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APPLETONS'

MECHANICS' MAGAZINE

AND

ENGINEERS' JOURNAL.

EDITED BY

THOMAS DREW STETSON.

VOL. III.

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APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 1.—Vol. III.—JANUARY 1st, 1853.

THE TELEGRAPHIC LINES OF THE WORLD.*

[For Appletons' Mechanics' Magazine.]

America.—In giving an account of the number of telegraphic lines, it will be proper to place the United States as first on the list, from the number and extent of the lines, and from the extensive use made of them in every department, both for business and pleasure. Still, it will be but an approximation to the number, for they are like the spider's web, forming a complete network over the length and breadth of the land, from the extreme northeastern point to the western boundary of Missouri, adjoining the Indian territory. A continuous line of telegraph now extends from the verge of civilization on the western frontier (east of the Rocky Mountains) to the northeastern extremity of the United States; and the time is not far distant when we shall have a telegraph from the Mississippi River to San Francisco. This is no fancy sketch, as the route is already selected for the California line, and a most interesting Report was presented to the Senate of the United States in the session of 1851, by the Committee on Post-Offices and Post-Roads.

"The route selected by the Committee is, according to the survey of Captain W. W. Chapman, U. S. Army, one of the best that could be adopted, possessing as it does great local advantages. It will commence at the city of Natchez, in the State of Mississippi, running through a well-settled portion of Northern Texas, to the town of El Paso, on the Rio Grande, in latitude 32°; thence to the junction of the Gila and Colorado rivers, crossing at the head of the Gulf of California, to San Diego, on the Pacific; thence along the coast to Monterey and San Francisco. By this route, the whole line between the Mississippi River and Pacific Ocean will be south of latitude 33°; consequently, almost entirely free from the great difficulties to be encountered, owing to the snow and ice on the northern route, by the way of the South Pass, crossing the Sierra Nevada Mountains in latitude 39°. The whole distance from the Mississippi to San Francisco will be about 2400 miles."

The great benefits to be derived, the Report fully and ably sets forth, whether in a military, commercial, or social point of view.

In the Congressional *Globe* of April 6, 1852, Mr. Douglass presented the memorial of Henry O'Rielly, proposing a system of intercommunication by mail and telegraph, between the Atlantic and Pacific States. All he asks is permission to establish a telegraphic line from the Mississippi Valley, where the wires now terminate, to the Pacific Ocean, and to be protected by a line of military posts, so that he can keep up the communication for the benefit both of the Government and of the public. Mr. O'Rielly states in this memorial, that within two years from this time, with this line completed, he would be able to deliver the European news on the shores of the Pacific within one week from the time it left the European Continent. The motion was referred to the Committee on Territories.

These are but a part of the advantages set forth in the bill, with a strong recommendation from the Committee for its passage.

The authorities of Newfoundland have granted to Mr. H. B. Tibbatts and associates, of New York, the exclusive right to construct and use the magnetic telegraph across that island, for the period of thirty years. The grant is designed to facilitate Mr. Tibbatts in his scheme for the establishment of steam and telegraphic communication between New York and Liverpool or London, *in five days*. The telegraph is to extend from New York to St. Johns, from whence a line of steamers is to run to Galway, where another line of telegraph is to commence, extending to London. This latter line will, it is said, be completed during the current year. The distance from St. Johns to Galway is 1647 miles, or about five days' sail.

There are numerous lines in actual and successful operation under the title of Morse, House, and Bain, each giving every facility to the business man.

The first American telegraphic line was established in May, 1844, between Washington and Baltimore, over a length of 40 miles.

The line from Washington to Baltimore also proceeds to Philadelphia and New York, over an extent of 250 miles. It reached Boston in 1845, and became the great line of the North, from which branched two others: one, the length of 1000 miles, from Philadelphia to Harrisburg, Lancaster, Pittsburg, Columbus, Cincinnati, Louisville (Kentucky), and St. Louis (Missouri); the other, the length of 1300 miles, from New York to Albany, Troy, Utica, Rochester, Buffalo, Erie, Cleveland (Ohio), Chicago (Illinois), and Milwaukie (Wisconsin).

A fourth line goes from Buffalo to Lockport, Queenstown, the Lakes Ontario and Erie, the Cataract of Niagara, Toronto, Kingston, Montreal, Quebec, Halifax, and the Atlantic Ocean, over an extent of 1395 miles.

Two lines South: one from Columbus to New Orleans, by Cincinnati; the other from Washington to New Orleans, by Fredericksburgh, Charleston, Savannah, and Mobile. The first is 1200 miles long, the second 1122 miles. This line has been extended West to Independence, Missouri.

The House Printing Telegraph has only been in operation since 1846, but even in that short time has spread itself over a large portion of the United States, working to the entire satisfaction of our business community, and wherever found, exciting the admiration of the curious, being able to print, in Roman capitals, communications in almost every language.

This line consists of the Boston and New York Telegraph Company, using the House Printing Telegraph; about 600 miles of wire, two wires; stations at Boston, Mass., Providence, R. I., Springfield, Mass., Hartford and New Haven, Conn., and New York.

A line is being constructed to connect with this Boston line, running from Springfield, Mass., to Albany, N. Y., there to intersect the New York and Buffalo line, using the same instruments, extending from New York to Buffalo, a distance of 570 miles. One wire is now in operation, connecting with Poughkeepsie, Troy, Albany, Utica, Syracuse, Lyons, Rochester, Albion, Lockport, and Buffalo; and another wire nearly completed, the same distance. This line is to continue to St. Louis, Mo., connecting with Cleveland, Cincinnati, Louisville, and St. Louis, which will be completed the entire distance in 1852, forming the longest line in the world under the direction of one company, the whole length being 1500 miles.

The New Jersey Magnetic Telegraph Company, using the House instruments, and the first line of this kind ever put in operation, extends from Philadelphia to New York; one wire 132 miles, and another now being put up.

The Atlantic and Pacific Telegraph range, under the arrangement of Henry O'Rielly, Esq., using a modification of Bain's Chemical Telegraph and Morse's instrument, from New York to Washington, and from New York to Boston. Also, the first division, constructed eastward of the Mississippi, known as the "Atlantic, Lake, and Mississippi Telegraph," extending to the Atlantic, and connecting nearly all principal cities and towns between the Canadian frontier and the Mexican Gulf—embracing the Ohio and Mississippi valleys, as well as the Lake country; about 6000 miles constructed, and 3000 miles contracted for construction.

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* Compiled principally from a series of articles by Dr. L. Turnbull, recently published in the Journal of the Franklin Institute.

The second division, westward of the Mississippi, to include the "Mississippi and Pacific Telegraph," of which about 500 miles of river distance, embracing the principal towns along the Missouri, between St. Louis and Fort Leavenworth, is contracted for construction, additional to other extensions in different quarters, west of the Mississippi, to be extended from Fort Leavenworth to San Francisco, when Congress authorizes the extension through the public domain.

The Bain Line, now a Morse Line, Mr. Henry J. Rodgers, General Superintendent, from New York to Washington, has lately constructed, at an expense of $10,000, spars 310 feet high, at the Palisades and Fort Washington, ten miles above the city of New York, for the purpose of sustaining their wires over the river, instead of the method formerly employed, by passing the current through the water, by wires laid across the North River. He considers this method, by means of suspension on spars, as being more permanent and durable.

The Bain Lines in the United States are as follows:

One from New York to Boston, 2 wires.

One from Boston to Portland, Me.

And one from New York to Buffalo, 2 wires.

The profits to the stockholders amount to from three to six per cent. per annum. The usual expense of constructing these lines varies from $100 to $200 per mile.

The following statistics, concerning a large number of the principal lines, have been derived from various sources:

Washington and New Orleans Telegraph, organized under Morse's patent; tariff of charges, $2.00. From Washington to New Orleans, 1716 miles, with 19 stations. No charge for address, signature, or date.

Atlantic and Ohio Telegraph Line, from Philadelphia to Pittsburg, Morse's patent.

Troy and Canada Telegraph, from Troy to Montreal, 14 stations.

The New York, Albany, and Buffalo Telegraph extends from New York to Buffalo, via Albany and Troy, 513 miles. Rates of charges, 65 cents. There are eighteen stations between Buffalo and New York; connecting at Troy with "Troy and Canada Junction Tel. Co.;" at Canandaigua, with a line thence to Jefferson, N. Y.; at Rochester, with a line thence to Daysville, N. Y.; at Buffalo, with "Buffalo and Canada Junction Tel. Co.; and with Erie and Michigan Tel. Co., the latter extending from Buffalo to Milwaukie, via Cleveland, Detroit, and Chicago, 800 miles; Morse's patent.

New York and Boston Magnetic Telegraph Company, from New York to Boston, about 250 miles; three wires, one passing through Providence, R. I., the other through Springfield, Mass., using the Morse patent.

Merchants' Telegraph Company, from New York to Boston, about 250 miles, two wires passing through Providence, using Bain's patent.

House's Printing Telegraph, from New York to Boston, 250 miles; one wire, uses House's patent.

Boston and Portland Telegraph Company, from Boston to Portland, 100 miles; one wire, using Morse's patent.

The Merchants' Telegraph Company have one wire from Boston to Portland, 100 miles; Bain's patent.

Maine Telegraph Company, from Portland to Calais, Maine, about 350 miles; one wire, Morse's patent.

St. Johns and Halifax line, from Calais to Halifax, about 400 miles; one wire, Morse's patent.

There is a line of Bain Telegraph from Boston, through New Hampshire to Burlington, Vt., thence to Ogsdensburg, New York, about 350 miles; one wire.

New York State Telegraph Company, from New York to Buffalo, via Albany, two wires, 550 miles long, with a branch from Syracuse to Ogsdensburg, via Oswego, about 150 miles, one wire; also a branch from Troy to Saratoga, 36 miles, one wire; use Bain's patent. There is also a Morse line from Syracuse to Oswego, about 40 miles.

House Telegraph Company, from New York to Buffalo, via Albany, 550 miles, two wires; use House's patent.

New York and Erie Telegraph, from New York to Dunkirk, via Newburgh, Binghamton, and Ithaca, 440 miles, one wire; Morse's patent.

New York and Erie Railroad Telegraph, for railroad use, along the line of New York and Erie Railroad, 460 miles; Morse's patent.

Magnetic Telegraph Company, from New York to Washington, via Philadelphia, seven wires, 260 miles; Morse's patent. Rates of charges, 50 cents; from New York to New Orleans, $2.50.

House's Line from New York to Philadelphia, 100 miles, 1 wire; House's patent.

Troy and Canada Junction Telegraph Company, from Troy to Montreal, through Burlington, Vt., 260 miles, one wire; Morse's patent.

Erie and Michigan Telegraph Company, from Buffalo to Milwaukie, via Cleveland, Detroit, and Chicago; one wire all the way; second wire from Buffalo to Cleveland; 800 miles long; Morse's patent.

Erie and Alleghany Tel. Co., from Dunkirk, N. Y., to Pittsburg, Pa., via Newcastle and Warren, Pa.

Cleveland and Cincinnati Telegraph Company, from Cleveland to Cincinnati, 250 miles long; two wires, Morse's patent.

Cincinnati to St. Louis, via Indianapolis, 400 miles long; one wire, Morse's patent.

Cleveland and Pittsburg Telegraph Company, from Cleveland to Pittsburg, 150 miles; one wire, Morse's patent.

Cleveland and Zanesville line, from Cleveland to Zanesville, 150 miles; one wire, Morse's patent.

Lake Erie Telegraph Company, from Buffalo to Detroit, via Cleveland, 400 miles; one wire, Morse's instrument, built under O'Rielly's contract with Morse, with branch from Cleveland to Pittsburg, 150 miles, one wire.

Cincinnati and Sandusky City line, about 200 miles; one wire, Morse's patent.

Toledo to Terre Haute, via Fort Wayne, about 300 miles; one wire, Morse's patent.

Chicago to Dayton, one wire; Morse's line.

Chicago to St. Louis, via Peoria, about 400 miles: one wire, Morse's patent.

Milwaukie to Green Bay, 200 miles; one wire, Morse's patent.

Milwaukie to Galena, via Madison, about 250 miles; one wire, Morse's patent.

Chicago to Janesville; one wire, Morse's patent.

Buffalo and Canada Junction Telegraph Company, from Buffalo to Lewiston; one wire, connecting with a wire in Canada that runs to Toronto, about 200 miles.

Montreal Telegraph Company, from Niagara to Quebec, via Montreal; one wire, Morse's patent.

Montreal to By Town; one wire, Morse's line.

There are three companies, if not four, owning the line from Boston to Halifax; from Boston to Portland there are two lines, one using the Morse instrument, and one the Bain instrument; from Portland to Calais, Maine, one company, using the Morse instrument; from Calais to Halifax, the Morse instrument is used; the line in each province is owned by separate companies, organized under charters from their respective legislatures.

[Dr. Turnbull, having stated in the July number of the Franklin Journal, that direct communication had been held between New York and New Orleans, the whole distance having been worked in one circuit, makes the following correction in a subsequent number:]

"The entire length of the line from New York to New Orleans, via Charleston, Savannah, and Mobile, is 1966 miles; and this distance was not worked in one circuit, nor can it be with either of the existing systems, with the best mode of insulating in use. The instance of direct communication was secured by dividing the line into several circuits, probably five or six, and connecting those circuits through the agency of an instrument termed a connector, the effect of which is to cause one circuit to work the other through the entire series, thus producing a result similar to working through the entire line in one circuit. The connector is an instrument first invented and applied by E. Cornell, Esq., of New York, on the New York, Albany, and Buffalo line, at Auburn, New York, to work a branch line from Auburn to Ithaca, for the purpose of taking news reports at Ithaca, at the same time the wire being transmitted from New York to Buffalo on the main line; this was adopted in the year 1846; it was found to work admirably, and he afterwards modified it so as to make it applicable to working both ways in a main line, or in other words, to make it capable of working a number of series of circuits in a main line; the instrument was adopted for this purpose on the New York and Erie, and Erie and Michigan lines, in the year 1849, and has been in constant use ever since; by it they have frequently worked direct from New York to Milwaukie, 1300 miles. The instrument used on the New Orleans line, which was described in my Lectures on the Telegraph, was adopted by Mr. Chas. Bulkley, the then superintendent of the line, who claims it as his invention, made in 1850 or 1851.

"The greatest distance that Mr. Cornell has known any lines to work in one circuit, was from Boston to Montreal, via New York, Buffalo, and Toronto, a distance of about 1500 miles; this, however, was done when the earth was frozen, and the lines thus insulated by the frost much better than man could insulate them without its aid. There are no lines working successfully in *one* circuit more than 550 miles; lines may be so insulated as to work in one circuit, under states of the atmosphere from 800 to 1000 miles."

The leading telegraph lines in the West, and South, and Northwest have lately been united in business interests. The New Orleans and Ohio line, extending from New Orleans to Pittsburg, the People's line from New Orleans to Louisville, the two wires, Louisville, Cincinnati, and Pittsburg line, and the Western line from Wheeling and Pittsburg to Baltimore and Washington City—are all direct parties to the contract, securing these arrangements.

The union brings the Morse and O'Rielly offices in Cincinnati, and all other cities on the lines named, together. In Cincinnati, the Morse lines are removed to the O'Rielly office, which will hereafter be known as the *National Telegraph Office.*

The lines connected directly by this union, connect also indirectly with wires extending over thousands of miles, and embracing within their iron arms almost every city and large town in the United States. Perhaps there are no lines of equal extent in the world, or working together with equal harmony, as those radiating from the National Telegraph Office in Cincinnati. They are seventeen in number, and embrace in all *ten thousand eight hundred and twenty-four miles of wire.*

The Report of the Cincinnati and Louisville Telegraph Company for 1850 and 1851, exhibits great enterprise, and the value of the telegraph as a mercantile investment in America. It appears that during the preceding year, three dividends of three per cent. each had been paid, and one quarter's dividend retained for rebuilding the line. The whole sum expended for repairs up to June, 1851, amounted to $10,405.94. With this sum, 83 miles of poles have been reset, 146 miles put in repair, and 156 miles renewed.

The total receipts for 1850 were - - -		$73,270 72
Paid to connecting lines, - -	24,788 45	
Expenditures, - - - -	35,013 57	59,802 90
Total Residue, - - - -		$13,476 72

Of the expenditures, only $734.25 were for cost of batteries, $1,253.61 for stationery, and $1,425.64 for miscellaneous, a large proportion being necessarily charged to salaries and repairs.

Statistics of the year 1850: Number of words transmitted, 3,602,760: number of dispatches recorded, 351,559. These are exclusive of free matter, necessarily large at all times. Average hours of labor, fourteen per day. The record of dispatches for 1850, on the paper of the registering instrument, covers a length of 1704¼ miles. Number of hands employed, 58.

The Law of Telegraph in the United States enjoins, under penalty of "a fine of not less than one hundred dollars, or imprisonment not exceeding six months, or both," inviolable secrecy on the part of all agents, operators, superintendents, &c., of Telegraph lines, with regard to the contents of Telegraphic Dispatches, except to the person or persons to whom directed. Provision is made, however, for the publication at any point of any general news which may be sent with a view to general publicity.

(To be continued.)

◆

History of Machines for working in Metal, Wood, and other Materials.[*]

BY PROF. R. WILLIS, M. A., F. R. S., ETC.

The object of such machines is to work rough material into shape, which may be done in three different ways: (1.) By abrading or cutting off the superfluous portions in the form of chips or large pieces; (2.) If it possess ductility, we knead it, or press it into form in various ways, as by hammering, rolling, drawing, &c.: (3.) If it be fusible, we melt it, and pour it into a mould. I forbear to include the producing a given form by joining together pieces, because each piece must be shaped in one or other of the above ways. The most interesting series of machines is that which belongs to the first group; and to this I must, for the present, confine my attention. It may be interesting to sketch the history of their introduction. Machines of this kind are either general, like the lathe or the planing-machines, which are used for a great variety of purposes, or are especially adapted to the production of a single object of manufacture; in which case they are often contrived in a series, as the block-machinery, the machines for making cedar pencils, and the like, and the introduction of such especial machines is of great importance, and has certainly not yet reached its limits. As the machines of this latter kind are commonly modifications of one or other of the first, the history of the two must be considered together.

The origin of the turning-lathe is lost in the shades of antiquity; and the saw-mill, with a complete self-action, turned by a water-wheel, is represented in a MS. of the thirteenth century at Paris, and is, probably, of much earlier contrivance. The lathe was, in process of time, adapted to the production of oval figures, twisted and swash-work, as it is called, and, lastly, of rose-engine work. The swash, or raking mouldings, were employed in the balusters of staircases and other ornaments at the period of the "Renaissance" in architecture, about the end of the sixteenth century, and, therefore, the swash-lathe assumes somewhat of the character of a manufacturing machine. But the simple lathe was much employed in screen and stall-work during the middle ages. The first real treatise on turning is Moxon's (1680), which gives us a valuable picture of the state of the art at that period, and he has preserved to us the name of the engine-manufacturer of that day, Mr. Thomas Oldfield, at the sign of the Flower-de luce, near the Savoy in the Strand, as an excellent maker of oval-engines, swash-engines, and all other engines, which shows that such machines were in demand. A few drawings of such machines occur in earlier works, beginning with Besson, in 1569. From the treatise of Plumier, published at Lyons in 1701, we learn that turning had long been a favorite pursuit in France with amateurs of all ranks, who spared no expense in the perfection and contrivance of elaborate machinery for the production of complex figures. This taste continued at least up to the French Revolution, and contributed in a very high degree to the advancement of the class of machinery that forms the subject of our present evening In our own country the literature of the subject is so defective that it is very difficult to discover what progress we were making during the seventeenth and eighteenth centuries. A few scattered hints only can be collected, whereas in France the great "Encyclopédie" and other works, abundantly illustrated, give the most precise and accurate knowledge of the state of this and other mechanical arts.

Smeaton has recorded that, in 1741, Hindley, the clockmaker of York, showed him a screw-cutting lathe, with change-wheels, by which he could, from the one screw of the lathe, cut screws of every necessary degree of fineness, and either right or left handed. It seems to be implied that this was a novelty, and that Hindley had invented it; and it was soon imitated by Ramsden, and is now universal. At all events, such a machine is not alluded to in the French works already mentioned, and serves to show the advance we were then making in the practical improvement of the lathe.

But the clockmakers, to which body Hindley belonged, were the first who employed *special machines* for their manufactures. Their *wheel-cutting engine* has been ascribed to Dr. Hooke, about 1655, and its use rapidly spread over the Continent. The gradual improvement of this machine, and the successive forms which it assumed as the art of construction was matured, forms a very instructive lesson. But herein our own countrymen have largely contributed to its perfection. Henry Sully, an English clockmaker, who removed to Paris about 1718, carried with him, amongst other excellent tools, a cutting-engine, which excited great admiration there. The form of the present French engine is, however, derived from Hulot's machine about (1763). But our English engines, in which the dividing-plate is superseded by a train of change-wheels, so contrived as to require an entire turn of a latch-handle for each shift, and thus secure against error, is derived from Hindley's engine, which he showed to Smeaton in 1741, and which finally passed into the hands of Mr. Reid of Edinburgh.

The *fusee-engine*, which is another special clockmaker's machine, must have greatly contributed to the perfection of machines for working in metal.

But the next great step towards the perfection of machine tools was the *slide-rest.* The slow and gradual way in which this invaluable device acquired the distinct and individual form in which it now exists, is a very curious example of the history of machinery, the development of which, at length, would occupy too much space on the present occasion, even if it could be made intelligible without drawings. Suffice it to say, that although as early as 1648 Maignan published at Rome[*] engravings of two curious lathes for turning the surfaces of metallic mirrors for optical purposes, in which the tool is clamped to frames, so disposed that when put in motion it is compelled to move so as to form true hyperbolical, spherical, or plane surfaces, according to the adjustment, and that although the fusee-engines, screw-cutting lathes, and other contrivances already alluded to, employed tools guided by mechanism, yet the real slide-rest does not make its appearance until 1772, when in the plates of the French "Encyclopédie"[*] we find complete drawings and details of an excellent slide-rest, as nearly as possible identical with that usually supplied by Messrs. Holtzappfel and other makers of lathes for amateurs. It must have been contrived a little while before this publication; but the meager descriptions that accompany the plates leave us completely in the dark with respect to its history. Bramah's slide-rest of 1794[†] is so different and so inferior in convenience, that the two could not have had a common origin; and we must suppose that the French slide-rest was unknown to that ingenious mechanist, although it is scarcely possible that copies of the "Encyclopedie" should not have found their way into our libraries.

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[*] From a lecture before the London Society of Arts, Manufactures, and Commerce.

[*] "Perspectiva Horaria." p. [illegible]

But the improvements of the steam-engine, its application to giving motion to the wheels of mills and other machines, the increasing employment of iron, and other advances in the construction of mechanism, which were now developing themselves, gave men courage to devise and carry out large and extensive schemes for the application of machinery to manufactures. In our especial department we may record, as an early example, Bramah, who, in 1784, obtained the patent for his admirable lock, and immediately set about the construction of a series of original machine tools, for shaping with the required precision the barrels, keys, and other parts of the contrivance, which, indeed, would have utterly failed unless they had been formed with the accuracy that machinery alone can give. In Bramah's workshop was educated the celebrated Henry Maudslay, who, as I am informed, worked with him from 1789 to 1796, and was employed in making the principal tools for the locks.

Foremost among the ingenious persons who carried on this great movement must be recorded Brigadier-general Sir Samuel Bentham.[‡]

From his own account it appears, that in 1791 steam-engines in this country were extensively employed for pumping mines, and for giving motion to machinery for working cotton, and to rolling-mills, and some other works in metal; but that in regard to working in wood, steam-engines had not been applied, for no machinery, other than turning-lathes, had been introduced, excepting that some circular and reciprocating saws and working tools had been applied to the purpose of blockmaking by the contractors who then supplied blocks to the navy; even saw-mills for slitting timber, though in extensive use abroad, were not to be found in this country.

General Bentham had at this time made great progress in contriving machinery for shaping wood, as is sufficiently shown by his remarkable specifications of 1791 and 1793; and he informs us that, rejecting the common classification of works according to the *trades* or *handicrafts* for which they are used, he *classed the several operations that have place in the working of materials of every description according to the nature of the operations themselves*, and, in regard to wood particularly, contrived machines for performing most of those operations whereby the need of skill and dexterity in the workman was dispensed with, and the machines were also capable of being worked by a steam-engine or other power. Besides the general operations of planing, rebating, mortising, sawing in curved, winding, and transverse directions, he completed, by way of example, machines for preparing all the parts of a sash-window and of a carriage-wheel, and actually showed these and other machines in a working state in 1794 in London.

This led to his appointment as Inspector-general of Naval Works, for the purpose of introducing these and various other machines into the royal dockyards, which he immediately set about effecting. From this time (1797) the introduction of machinery for the preparation of blocks and other works in wood at Portsmouth, Plymouth, and other Government establishments, takes its origin. In 1802 the General received a most powerful and efficient auxiliary in the person of Mr. Brunel, who in that year presented his plans for the block-making machinery. His services being immediately secured, and Mr. Henry Maudslay engaged for the construction of the mechanism, the admirable series of machine-tools were finished and set to work in 1807, by which every part of the block and its sheaves are prepared.

The completeness and ingenuity of this system, the beauty of its action, and the novelty of the forms and construction of the whole of the mechanism, excited so much admiration, that the whole of the machinery in Portsmouth dockyard has usually been popularly ascribed to Mr. Brunel alone. It must not be forgotten, however, that much machinery for the performance of isolated operations had been previously employed, as well by Mr. Taylor of Southampton, the contractor for the blocks of the navy previously to 1807, as by General Bentham himself in the dockyards.

At this distance of time it would be impossible to discover the exact shares of merit and invention that belong to Brunel, Bentham, and Maudslay, in this great work. To the first we may, however, assign the merit of completing and organizing a system of machine-tools, so connected in series, that each in turn should take up the work from a previous one and carry it on another step towards completion, so that the attendant should merely carry away the work delivered from one machine and place it in the next, finally receiving it complete from the last.

Some of the individual machines in the series had, it is true, been previously contrived and employed. Thus, the self-acting mortising-machine is distinctly described in Bentham's specification of 1793, so completely as to entitle him to the full credit of the invention of mortising-machines, whether by the process of boring a hole first and then elongating it by a chisel travelling up and down vertically, or by the process of causing the hole to be elongated by the rotation of the boring-bit during the travelling of the work. The same specification describes boring-machines, some of which are similar in their arrangements to those of the block series; also the tubular gouge, which is employed in the shaping-machine, and the formation of recesses, by a revolving and travelling tool for the inlaying of the *coaks*.

One of the most useful machine-tools that made its appearance at the end of the eighteenth century was the *circular saw*. This had been applied to cutting metal on a small scale, as in the cutting-engine, ever since the time of Dr. Hooke; if, indeed, these early examples were not more like circular files than saws. Where or by whom the woodcutter's saw was put into the form of a revolving disk has not been recorded. It found its way into this country about 1790, some say from Holland, and was employed at Southampton and elsewhere in wood-mills. Bentham greatly contributed to the practical arrangements necessary to give it a convenient form. He describes and claims the bench now universally used, with the slit, parallel guide, and sliding bevel-guide, and other contrivances.[*] Brunel introduced a variety of ingenious and novel arrangements, as well as the mode of making large circular saws of many pieces.[†] Mr. Smart also contrived a series of sawing-machines for making canteens, cutting tenons, &c.

After the completion of the block machinery, it becomes very difficult to trace the subsequent improvements. The art of machine-making for working in metal was gradually advancing, but is not recorded in patents, and very little described in books. The slide-rest principle was extended, large self-acting lathes constructed, and boring-machines of great precision and improving structure were called into existence by the necessity for extreme accuracy in the cylinders of steam-engines. The best engravings of the machines of this period are in "Rees' Cyclopædia," and in the volumes of the "Transactions" of the Society of Arts.

No greater proof of the obscurity which hangs over the history of machine-tool making, in the first half of this century, can be given, than the unknown origin of the planing-machine for metal. The machine which Nicholas Focq contrived in 1751, which has been called a planing-machine, has no title to the name, or any resemblance to the modern engine. It is nothing but a heavy scraping-tool, which is dragged along the bar upon which it is to operate, and rests upon it, pressed into hard contact with it by strong springs. It will, therefore, smooth the surface, and remove small irregularities, as a carpenter's plane does with a board, but it will not produce a correct plane surface, or even make successive cuts. It is a mere *plane*, and not a *plane-creating machine*. Neither could the machines patented by Bentham in 1791, and Bramah in 1802, for planing wood, although real planing-engines, have suggested the engine in question, for their properties and arrangements are wholly different. The engineer's planing-machine made its way into the engineering world silently and unnoticed; and some years afterwards, when its utility became recognized and men began to inquire into its history, various claimants to the honor of its invention were put forward. We can only learn that, somewhere about 1820 or 1821, a machine of this kind was made by several engineers. Messrs. Fox of Derby, and Roberts of Manchester, appear amongst the number, and the forms which they gave to the engine have remained permanent. Mr. Clement has also been mentioned, as well as others. It is clear that the inventors were not at all aware of the immense importance of their work, but experience has proved the utility of this machine to be so great, that it may be pronounced the greatest boon to constructive mechanism since the invention of the lathe. Nevertheless, no drawing or description of the planing-engine is to be found in any English book until 1833, when the Society of Arts published beautiful engravings of Mr. Clement's machine; the complexity of this, and the unfortunate arrangement of the bed, which he mounted on wheels, has prevented it from being adopted. The French and other Continental mechanical journals, much earlier began to give engravings and descriptions of the English planing-machine. In 1829 the "Industriel" has one of the simplest, and the Bulletin of the "Société d'Encouragement," the collections of Le Blanc, Armengaud, and others, contain engravings, not only of the planing-machines, but of the other machine-tools of all our best English makers, generally accompanied by admirable descriptions and minute details, that may well serve as models to our own writers on such subjects, and at the same time show how much good service is rendered by the superior mathematical and theoretical education of French engineers. Be it remembered, too, that, not content with describing and analyzing our machine-tools, which they do in a most liberal and admiring spirit, they also employ their generalizing powers in the endeavor to construct improved forms, and with such great promise of success, that, unless we also begin to apply science to this subject, we run considerable risk of falling behind our ingenious neighbors.

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[*] Tom. x. pls. 37, 38, 84, 85, 86.

[†] Weale's edition of "Buchanan's Mill-work."

[‡] Bentham's patents, "Repertory of Arts," vol. v. p. 293, and vol. x. pp. 221, 293, 357; also Memoir, by Mrs. Bentham, in Weale's "Quarterly Papers on Engineering," vol. vi.

[*] 1793. Repertory, vol. x. p. 293.

[†] Patent, 1802.

The mortising-engine of the block machinery was applied by Mr. Roberts, of Manchester, to the formation of the key-ways of cast-iron wheels, and also to the paring, or planing by short strokes, of the sides of small curvilinear pieces of metal; such as cams, short levers, and other pieces that do not admit of being finished in the lathe. Thus, under the name of *slotting and paring-machine*, a new and generally useful machine-tool sprang up; and subsequently another, derived from it, has been produced, and apparently with equal success, under the title of a *shaping-machine*. It is, in fact, a planing-machine, in which the tool is attached to the end of a horizontal bar, which is moved to and fro, so as to plane, with short transverse strokes, a piece of work fixed on a complex adjusting-bed, or on a revolving mandril, so as to receive the action of the tool.

The existence of such principles leads us to hope that machines much more comprehensive, and yet simpler in form, will be devised for the same purposes, by means of which the construction of machinery in general will attain to greater perfection; and machine-tools be introduced into workshops of a smaller character than at present, in the same manner as the lathe.

In America, a variety of contrivances are employed in workshops to facilitate and give precision to ordinary operations: as, for example, the foot-mortising machine for wood. The earliest contrivance of this useful tool (the offspring of Bentham's mortising-engine), appears to be in a Pennsylvanian patent by John M'Clintic, in 1827,* since which the machine has got into general use in America, and has consequently been the subject of numerous patents for minor arrangements. One of these, by Page, was engraved in the "Mechanics' Magazine" (1836, vol. xxvi. p. 385), and thus introduced to English workmen; and in the last year Mr. Furness, of Liverpool, has patented some improvements in England, and endeavored to introduce the machine. It formed a very interesting object in the Exhibition, together with other American contrivances for boring, tenoning, and such like operations, which the peculiar conditions of that country have called into existence, by creating a market for them.

In reviewing the comparatively slow progress of machine-tool making, it will appear that in this, as in other branches, steps in invention that, when once made, appear exceedingly simple and obvious, are often the most difficult to take. The chance that such steps will be made is increased by bringing to bear upon them the greatest number of heads; for the peculiar faculties or acquirements of one man, or set of men, may serve to carry on an invention to a certain point which it is prepared for, and requires those of another set of men who may carry it further. In the old time, the exceeding secrecy and jealous care with which every new contrivance was guarded and watched, retarded the advance of machinery to an extent that we can hardly believe. Each man was working in ignorance of his neighbor's improvements, and every Art was indeed a Mystery. And not only did these difficulties obstruct the progress of machinery, but the enormous expense of constructing new machines. We know the art of construction has undergone a complete revolution since the block machinery was made, but we can scarcely estimate the prodigious amount of labor and thought that was required to give existence to that machinery, which, indeed, could never have been effected without the resources of the nation in the then imperfect state of the art. To these retarding causes must be added the jealousies of workmen and their dislike of new methods.

I have already alluded to the advantage of promoting a more universal knowledge of each other's methods amongst the mechanics of different branches and countries. A very interesting part of the Great Exhibition was the collection of strange-looking tools from France, Germany, and elsewhere, differing in their forms and handles and mode of operation from those employed for the same purposes, by our own workmen. Without doubt some of them might afford useful hints; for example, the universal employment of the narrow frame-saw on the Continent for work that we perform with broad-bladed saws, stiffened with brass or iron backs, might lead our workmen to consider whether, after all, our practice is not carried too far in this respect.

But the facilities for working in metal, and its general introduction into all kinds of frame-work, where wood was exclusively employed, as well as the substitution of cast-iron for brass, has made it imperative upon persons of all trades which are affected by these changes, to learn the management of these new materials, if they desire to profit by the advantages consequent upon their employment. Thus, the philosophical instrument makers formerly employed brass for their metal work, and constructed their machines, even the largest astronomical instruments, in a great number of pieces screwed together. We have now learnt that stability is best insured by employing fewer pieces, and that cast-iron is, on all grounds, a better material than brass. But the tools and methods of working in cast-iron are wholly different, and therefore the philosophical instrument makers must turn engineers, and employ planing-machines and the like. The making of large clocks, and various other articles of common use, must undergo the same change. It is useless to say that these men can go to an engineer's shop to get jobs done for them as required. Such a method can only lead to a partial and imperfect employment of the new resources and advantages which are to be developed. For instead of a full and complete adoption of these novelties, the use of them will be necessarily evaded in every case where they can be dispensed with, unless the master-workman can employ them freely as his own.

In machinery we have to deal with every kind of material, and to avail ourselves of the peculiar properties of all, in their appropriate places; and thus a skilful engineer should be familiar with every kind of mechanical manipulation and material, from a sheet of card paper to an iron bar, and ought to know as well how to hem a pocket-handkerchief as to rivet a boiler. It is of no use for him to employ workmen of any trade in carrying out new combinations unless he himself know how to instruct them. A musician who is about to compose a symphony need not be able to play on the violin like Paganini, or on the piano like Thalberg, but he must be well acquainted with the powers and manipulations of these and every other instrument before he can write passages that will bring out their effects and be adapted to performance. And, in the same way, a man who intends to devise and carry out a new machine must be conversant with the peculiar properties and mode of manipulating every kind of material, that thus he may select and avail himself of them to the best advantage.

And I am persuaded that one of the most important and instructive lessons which the Great Exhibition brought before us, consisted in the display and contrast of the application of different materials and different methods to identical purposes by the various nations of the universe. May we be enabled to read the lesson aright.

On Oblique or Twisted Driving Bands.*

The application of bands, or belts, to convey motion between non-parallel axes, is one of the many modern improvements in mill-work. The problem is by no means self-evident, and frequently gives considerable trouble to those who only know that it is possible, but have not got firm or full hold of the principle. The rationale is, however, easily comprehended, and admits of a very brief explanation.

Let us consider, in the first place, the principle of the direct and open belt. In this case the axes are parallel, and the pulleys, or drums, are commonly cylindrical. The belt has no tendency to change its position laterally, for there is no reason why it should shift to one side rather than the other. But if one of the cylindrical pulleys is replaced by one slightly tapered—which sometimes happens unintentionally—the belt is observed to advance gradually towards the base, and not towards the apex of the conical drum, as might at first sight be expected. The reason is, simply, that the edge of the belt nearest the base is tightest, and is wound up more rapidly than the other edge, on account of the greater diameter of that end of the cone—exactly as in winding a band of paper, or the like, on a roller which is somewhat larger at one end than it is at the other; the paper advances, or *draws* towards the larger end. So it is with the belt: it advances towards the side of the greater diameter, precisely as if it were wound, or lapped continuously round the drum, and with proportionally greater rapidity as the taper of the cone is greater.

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* "Journal of Franklin Institute," vol. vi. pp. 18 and 163.

* From the Glasgow Prac. Mechanics' Journal

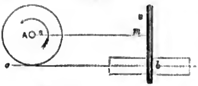
Advantage is frequently taken of this tendency of the belt to advance upon the larger diameter of a pulley, to form the pulleys somewhat convex at the middle of their width—as if composed each of two portions of cones joined at their bases. In consequence of this convexity—usually very slight—the belt keeps its place much more certainly than when the pulleys are plain cylinders. It has then, as we see, a decided tendency to remain on the pulleys, and it can have none whatever to run off. With this simple provision, belts are found, indeed, to keep their places on the pulleys, even when subjected to very considerable vibratory oscillations on account of inequalities of the belt itself—as irregularity of stretch, and imperfect joinings. Advantage is also especially taken of this curious property in the case of guide-pulleys, which are commonly very much *rounded* on this breadth; and also, when the axes are in different planes and not parallel, which is the only case we propose meantime to consider.

The circumstance, however, which makes oblique or twisted belts possible, is the following:—When a belt is to be shifted during motion to a new position on the drum or pulley it is driving, or from one to another of two equal and contiguous pulleys—fast and loose usually—it is necessary to apply the lateral pressure on the *advancing side* of the belt; that is to say, on the side of the belt which is approaching or running towards the pulley, and not on the *retiring side*, or that side which is travelling from, or is running off the pulley. If applied on the advancing side, a very small amount of pressure is sufficient to shift the belt; but an equal, or much greater amount of pressure applied on the retiring side produces no change on its position. No effect is, indeed, produced by displacing the side of the belt very considerably out of the plane of rotation of the pulley *from* which it is travelling; but the effect of a very small displacement from the plane of the pulley *to* which it is approaching is immediate.

From this it is not difficult to infer, that in order that a belt may maintain its position, it is only necessary that its advancing side should lie in the plane of rotation of that section of the pulley upon which it is required to remain, without regard to the retiring side, which may be deviated from that plane without in any way affecting the working of the belt. The correctness of this inference is corroborated by ample experience; and, as already intimated, it is that on which the contrivance of twisted belts fundamentally depends.

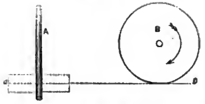
Let us suppose that A and B denote the positions of two shafts situated at right angles to each other—A, vertical, and B, horizontal—so that a line *m n*, perpendicular to the direction of one axis, shall also be perpendicular to the direction of the other; and let it be required to connect them by a pair of pulleys and an endless band in such a way, that their directions of motion shall be those indicated by the arrows in Figs. 1 and 2, and their velocities, 3 of A, to 2 of B. On A, as centre, let us describe the circle of the pulley we propose to employ on that shaft; then a tangent *a b*, drawn to the circumference of that pulley, and perpendicular to the axis B, and therefore parallel to the line *m n*, determines the plane in which the side of the belt retiring from A towards B must travel. For the plane of rotation of the pulley on B, is necessarily perpendicular to its axis of motion; and the belt must be delivered by the pulley on A, into that plane, namely, the plane of rotation of that pulley. The position of this last is accordingly indicated (in plan) by the dotted outline in Fig. 1; bisected in breadth, of course, by the tangent plane *a b*, and limited in diameter by the relative velocities of the two axes.

Fig. 1.



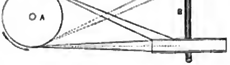
In this way the position of the pulley on the axis B is determined; but it still remains to determine the position of the pulley on the axis A. This is done, however, in precisely the same manner. Thus, let Fig. 2 be another view of the arrangement taken at right angles to Fig. 1 above; and let the axis B have the direction of motion indicated by the arrow; then the circle of the pulley being described, and a tangent *a′ b′* drawn to it, perpendicular to the axis B, as before, we have determined, likewise, the situation of the pulley on the axis A.

Fig. 2



The positions of the two pulleys are thus fixed in such a way, that the belt is always delivered by the pulley it is receding from into the plane of rotation of the pulley towards which it is approaching, which is the one necessary and sufficient condition indicated above.

Fig. 3



It is easy to perceive, that if, in this arrangement, the motion be reversed, the belt will immediately fall off the pulleys; for the required essentially necessary condition, that the belt shall always be in the plane of rotation of the pulley which it is approaching, is then no longer fulfilled; the belt approaches the pulley obliquely, in a path which makes an angle, more or less considerable, with the plane of rotation; and tending to run straight, it necessarily falls off. The direction of motion cannot, therefore, be overlooked; but must previously be settled and taken into account in fixing the positions of the pulleys on their shafts. This is abundantly plain from what precedes, and is further illustrated by the cut, Fig. 3, which shows the change of position of the pulley on B, when the direction of motion of the axis A is reversed—the full lines of the figure correspond, of course, to the direction of motion denoted by the full-line arrow; and the dotted position of the pulley on B, to the direction of motion indicated by the dotted arrow. The same change takes place in the position of the pulley on A, when the direction of the motion of the axis B is changed; but the single view is sufficient for illustrating both cases. We need not, therefore, repeat the figure.

In what precedes, we have, for the sake of simplicity of illustration, assumed the direction of the axes to be perpendicular to each other; but this is by no means an essentially necessary condition. The axes may be situated at any angle whatever to each other, from 0° to 90°, if only by turning them through the given angle, till their planes of direction coincide, the shafts are then parallel. In other words, the perpendicular drawn to one axis must necessarily be also a perpendicular to the other. If otherwise—if the perpendicular is not common to the two axes, recourse must be had to guide-pulleys, to conduct the belt. We may, indeed, regard the axes as primarily parallel, situated in parallel planes, and that one of them is moved *in its plane*, till it forms any angle of direction with the other up to 90°. The situations of the pulleys will obviously be determined, as already indicated, by tangents to their circumferences, perpendicular to the shaft towards which the belt is on that side required to travel; and both tangents will be parallel to the common perpendicular *m n*.

It is, by some, objected to this mode of driving, that it tends to wear out the belts very quickly, on account of the twist thrown upon them. This evil is, however, sensibly felt, only when the distance between the pulleys is not sufficiently great; when the belt is very long the objection vanishes.

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The Diagonal Principle in Ship-building.

The *El Primero* and the *Segundo* are two of five steamers constructed on the diagonal principle by Mr. John Thompson of Rotherhithe, for the service of the Spanish Government in the West Indian seas. These "diagonal" vessels, says the London Mechanics' Magazine, in a notice of the launch of the latter, have realized new triumphs for that highly ingenious and eminently successful principle of construction. Arranged as the timbers of these vessels are, they form a diagonally-trussed frame in every direction, the strength of which is easily understood; as it promotes a transmission and distribution of any undue strain, while the safety of the structure is immensely increased.

In this mode of construction, sections of the vessel are taken at suitable points of her length, at an average distance apart of about nine feet, and temporarily hung up in their proper positions with reference to the ways. Along these sections, the planks of the inner "shell" of the vessel, as it is termed, are laid, inclining at an angle of 45° to the line of midships. These planks continue from gunwale to gunwale, and have their edges accurately in contact. Outside these are placed the planks of the middle shell, also inclined at an angle of 45°, but in a contrary sense to those of the inner shell, and therefore intersecting them at right angles. At the intersection of each pair of seams, the two shells are firmly united by copper rivets, and outside all comes the exterior shell, the planks of which are laid in the usual manner, but with the precaution of covering the lines in which the intersections of the inner cores lie, and terminating in a rabbet in the stem and the stern. The keel is bolted strongly through the mass to the floors and futtocks, which are similarly secured. Between each pair of shells, a layer of patent felt cloth, saturated with tar, is placed, which tends still further to augment the security of the whole mass. Both the *Primero* and the vessel launched on Saturday, the *Segundo*, are divided into three non-communicating segments by bulkheads of similar construction. Each shell is made of inch-and-a-half planks of fine mahogany, worked up with the accuracy of a piece of joinery, and all the interval connections are extremely perfect. From the nature of the construction it is evident that, so long as one division of the vessel is free of water, or so long as one case remains together, there is safety for the crew, and in the last extremity a large shattered fragment of the sides of the vessel must form an admirable raft. With these successful examples of the application of the diagonal principle before our eyes—remembering too the excellent working of some of the Woolwich and Brighton boats, which were built by Mr. Thompson on the same general rules as the boats built by him for the navy—it is to be hoped that still further efforts will be made to perfect it by extending it to every service in which its peculiar features can be advantageous.

Messrs. J. & R. White, ship-builders, of Cowes, have improved upon this system by sacrificing the strength of this continuous shell, to a certain extent, in favor of the keel. Messrs. W., finding that the keel of ships built with diagonal planking was very much weakened by the diagonal planks being carried over and across it, conceived the idea of making the diagonal planks terminate in rabbets cut on each side of the keel. By this arrangement, the keel is capable of being of the same depth and thickness from stem to stern, and the diagonal planks serve to support it. The whole ship is necessarily much strengthened. We understand that two large steamships are being laid down on this plan by Messrs. White, one of which is for the Royal West India Mail Steam Packet Company. The invention, in the language of the specification, consists in forming a solid keel from stem to stern, of the same thickness and depth throughout, with grooves or rabbets cut therein for the reception of the diagonal planks, which do not cross the keel, but terminate on each side of it in the grooves or rabbets. The keel being laid in a continuous length, the floor timbers crossed, and the keelson laid and bolted thereto at the commencement of building, we obtain a permanent and solid foundation on which to construct the ship; the planking of the bottom is facilitated, and one length of planking extends from the keel to the gunwales; the ship is much stronger than if the keel were cut to allow of the diagonal planks being carried across it, and we are also enabled to build ships with diagonal skins or coats of any rise of floor.

Fig. 1.

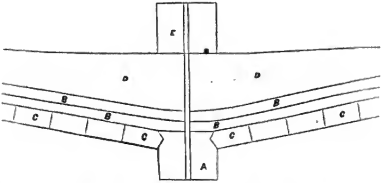


Fig. 1 is part of a midship section of a vessel constructed according to the present method of diagonal ship-building. A is the hanging keel; B B the diagonal planking; C C the outer and longitudinal planking by which, together with bolts, the hanging keel is supported; D D are the floor timbers, and E is the keelson.

Fig. 2.

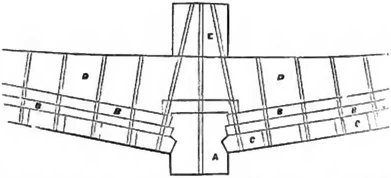
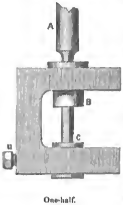


Fig. 2 is part of a midship section of a vessel constructed according to our improvements. A is the keel, solid throughout, having rabbets on each side for the reception of the ends of the diagonal planks B B, and the outer planks C C; D D are the floor timbers, and E is the keelson. The keel is here supported by both the diagonal and longitudinal planks, and the ship is thereby consequently much strengthened.

Spindle Foot Bearings for Spinn'ng Machinery.



One-half.

Registered for Mr. C. Carr, *Stockport.*

Our engraving represents this modification of the spindle rail, collar, and footstep, in end elevation. The spindle A has a long foot-piece, which is passed through a collar B in the upper flange of the rail, thus receiving lateral support, whilst it rests on the footstep C in the lower flange, this footstep being stayed by a back-set screw D. This arrangement evidently affords an excellent steadying support for the spindle, preventing the wear and tear of the foot, where failure usually first shows itself. It also permits of easy oiling. It is now being introduced by Messrs. Elce & Co., the machine makers of the Phœnix Works, Manchester, Eng.

◆

Illingworth's Adjustable Eccentric.

It frequently happens that it is required to alter the position of an eccentric or cam on its shaft, either to vary the rate of expansion, or for any of the endless purposes to which cams are employed. For this purpose, Messrs. Illingworth and Sons, engineers, of Shipley, Yorkshire, have designed and registered a convenient method, represented in the accompanying engraving.

Fig. 1.

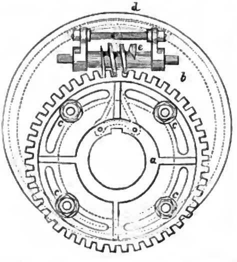


Fig. 2.

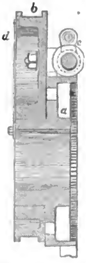


Fig. 1 is a side elevation, and Fig. 2 a transverse section, of the eccentric.

The worm-wheel *a* is keyed on the crank-shaft of the engine, and the boss is prolonged to form a seat for the eccentric *b*, the latter being free to revolve, and being held in contact with the worm-wheel by the four bolts *c c c c*. Motion is given to the eccentric by the worm *e*, whilst the relative position of the eccentric and wheel is indicated by a pointer *d* fixed to the latter, which remains stationary, whilst a scale attached to the eccentric moves past it.

◆

Steam-Engines and Boilers.*

W. B. Johnson, *Engineer, Manchester.—Enrolled, June* 12, 1851.

Mr. Johnson's improvements in steam-engines relate to various modifications of the mechanical arrangements of the details—such as the placing a condenser beneath the cylinder of a horizontal engine, so as to form a part of the base-plate; various minor modifications of parallel motions, air-pumps, and condensers; and a piston and valve-packing, with the spring acting in the line of a chord to the circle of the piston or valve. Under the second head he gives us several novel forms of boilers. His first boiler design appears to be the same as that already patented by Mr. Bourry*—the transverse section being made up of two arcs of circles, or ellipses, placed one above the other. Our figures, 1 and 2, represent transverse and longitudinal sections of

Fig. 1.

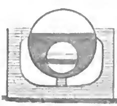
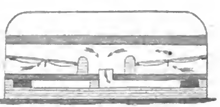


Fig. 2.



another arrangement of a cylindrical boiler, with an internal flue, running directly through the shell. The furnaces, two in number, are placed, one at each end of this flue, and the gaseous currents therefrom traverse—as shown by the arrows—meeting and mingling with each other in the central space between the two bridges. There the gases are well mixed and ignited, prior to the combined current passing off through the outside bottom flues. Figs. 3 and 4 exhibit similar sec-

Fig. 3.

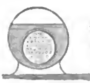
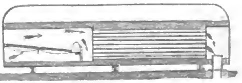


Fig. 4.



tions of a tubular boiler with a single furnace. The gases here pass from the furnace into the chamber at the back of the bridge, and thence through the flue tubes into an end smoke-box, in communication with the chimney flue. The smoke-box has an end door for cleaning, and is well surrounded with water.

Mr. Johnson also shows some other modifications of boilers, specially contrived for the prevention of smoke, durability, and economy of fuel.

◆

The Iron Trade in Scotland.

In Glasgow and its suburbs there are no less than thirty-eight iron foundries, all in full operation, besides two now building, and three old ones not at work. The extensive malleable iron works of the West of Scotland Iron Company, at Motherwell, near Glasgow, were lately exposed to sale at the upset price of £23,000, and sold, after a keen competition, for £42,050, to the Glasgow Iron Company. These works were erected a few years since at a cost of upwards of £106,000. They are to be set to work immediately, with at least 250 workmen, to produce malleable iron. It is said (by the *Falkirk Herald*), that the iron trade about that town has all at once resumed a degree of activity unprecedented for some years, and that the price of coals has risen. Should prices continue as at present, the *Herald* declares that the Messrs. Baird (of Gartsherrie, we presume) "will realize nearly £100,000 a year of additional profit on the produce of their own furnaces." If the English masters ever had reason to dread the over-production of the Scottish furnaces, they would now appear to have it. The *North British Mail*, in reference to the present and prospective state of affairs, says: "Does the increase in ship-building, which may warrant a rise in plates and bars, justify the advance in pig-iron of sixty-five per cent.; or will ship-building, although carried on to three times the extent it now is, take away the yearly surplus of iron that is now made? We think not. If the railway mania of 1845 and 1846 could clear away the stock that the new furnaces then in existence could produce, how can it for a moment be thought that even a great increase in ship-building and the same railway mania again can take away what the lately discovered ores of the counties of Ayr, Durham, Northampton and Cumberland are adding to the production? In Glasgow and neighborhood alone we have surplus of 400,000 tons, which speculators are busy putting into the same stores, where, in 1846, many of them left their fortunes behind them." The last report of the Glasgow market conveys an intimation which may perhaps check the mania which appears to be breaking out in more quarters than one. It says: "Our pig-iron market opened good this week at 60s., but has since gradually declined to 57s., cash for warrants, at which sales were made to-day for prompt payment. The late advance has materially interfered with both shipments and local consumption, and the very large quantity of iron being delivered into store had quite alarmed the trade here, who now operate with great caution. The stock is decidedly on the increase.—*Glasgow paper.*

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* From the Glasgow Practical Mechanic.

* Represented page 223, vol. 2, Appleton's Mech. Mag.

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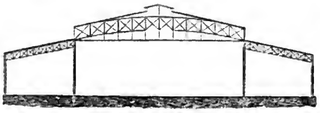
For Appletons' Mechanics' Magazine.

The Albany Iron Works.

The Albany Iron Works, situated at Troy, N. Y., the property of Mr. Erastus Corning, of Albany, and Mr. John F. Winslow, of the former place, were entirely destroyed by fire in the month of June last, and are yet only partially rebuilt; temporary wooden sheds on the water privileges having for the time supplied the wants which will ultimately be met by the erection of another splendid brick and iron building, similar in its general features to the one already in operation, and which it is the object of this article to describe. The design and general arrangement of this mill, which is justly considered one of the finest in the country, is due to Mr. Winslow, one of the proprietors, who has also introduced a number of improvements in different branches of the work, and to whose practical and scientific information, assisted by the experience and skill of the foremen of the different departments, several of whom have served in that capacity from fifteen to twenty years, is due in a great degree to the success of this widely known and extensive concern.

The mill is driven entirely by steam, generated by the spent heat from the furnaces. The main building is 330 by 135 feet, with two wings, one 50 by 75, the other 22 by 36 feet. The walls are entirely of brick, the doors and frames of iron, and the roof of matched pine boards, covered with tin. The roof is supported by trusses of cast and wrought iron, resting at their ends on cast-iron pillars, as shown in Fig. 1, which is a sketch of a vertical cross-section of the building, excluding the wings.

Fig. 1.



Scale—1 inch = 40 feet.

The pillars are of a cruciform section, measuring 12 inches in each direction, very nearly parallel throughout, and weighing one ton each. There are in the main building 26 of the large trusses, and 52 pillars. The brick walls are 12 inches, with antes 20 inches in thickness, amply lighted by three tiers of windows at the ends, and a large window over each door surmounted by an elliptical arch. The doors are of sheet-iron, No. 15 wire gage. They are 8 feet wide, 9 high, and arranged 12 feet apart between the centres, with the exception of one 20 feet square at the south end. A break is made in the roof near the apex, leaving an opening on each side 18 inches high, and extending the whole length of the building. These openings are for ventilation, and may be partially closed by lattice-work, should it be found necessary in winter. The vertical rise of 6 feet over the rows of pillars is entirely of iron and glass, and the effect of the whole structure, so light, durable, and liberal in its proportions, inclosing in one room $1\frac{1}{4}$ acres of brick paved floor, is decided and pleasing in the extreme.

There are 14 Puddling, 1 Boiling, 1 Scrapping, and 6 Heating or Re-heating Furnaces, all of the ordinary construction. Ten Boilers, receiving the heat from as many furnaces, generate steam for the 5 engines employed in the building. Of the boilers, 8 are plain cylinders, 40 feet long and 3 feet diameter; the remaining two are respectively 30 and 20 by 4 feet, and provided each with two 15-inch return flues. The boilers are each weighted at about 75 lbs., the working pressure ranging from that point as low as 25 lbs. per square inch. The boilers are connected together by one general steam-pipe of 8 inches internal diameter, provision being made for excluding any part when desirable, and are fed by two Worthington pumps, Nos. 2 and 4. These are the only pumps about the establishment, and taking the water from a source somewhat higher than themselves, their duty is simply forcing the water into the boilers and tanks. The arrangement of the cylinder boilers with reference to the furnaces is very simple. Each boiler is connected with a single furnace and stack, being set at a convenient elevation, the heat descending from the furnace through an inclined passage of little more than the ordinary area.

The engines are all non-condensing. One horizontal engine, 6 feet stroke, 30 inches diameter, with poppet valves, cutting off at $\frac{3}{8}$ stroke from the commencement, and making 24 revolutions per minute, drives the patent squeezer, the ball rollers, and 16-in. Merchant mill. The geering consists of 16-feet spur-wheel on crank shaft working into a 5-feet pinion on fly-wheel shaft—the fly-wheel is 20 feet diameter, with solid ring and arms (2 pieces only) weighing 19 tons, and makes 75 turns per minute. On the opposite end of the fly-wheel shaft are two spur-wheels, from which motion is communicated to the 16-in. Merchant mill, revolving 65 turns per minute.

The engine next in size is worthy of attention. It is also horizontal—stroke 20 inches, diameter 20 inches, short slide-valve, works without expansion, and drives two guide-mills 6 inches and 9 inches each. The crank shaft revolves 150 to 180 turns per minute, and turns the 9-inch mill without any intermediate gearing or other connections, approximating the conditions of a locomotive at high velocities; its full ordinary speed being equivalent to that of an express locomotive with 7-feet driving wheels, travelling 45 miles per hour. This is presumed to be the only instance of direct application of a steam-engine to drive a rolling-mill in this country; its advantages, under the circumstances, are obvious, and may be readily appreciated on examination.

One horizontal engine, 3 feet stroke, 12 in. diameter, making about 70 revolutions, runs two hammers. These hammers weigh each 700 lbs., and are driven entirely by belts. One upright engine, 3 feet by 9-inch cylinder, making about 25 revolutions, drives the blower for the heating furnaces; and one 18 by 10 inch engine, making 25 to 30 revolutions, drives the machinery of the lathe-room, in the smaller wing of the building. The boilers being all in connection, and the heavier departments of the work being rarely in operation all at the same time, tends in some measure to equalize the consumption of steam; yet so variable is the load necessarily thrown upon the engines, that the pressure is sometimes seriously reduced in a short space of time. The facilities for increasing the quantity of steam generated are so simple, however, that additional boilers will doubtless be employed in connection with the remaining furnaces, in preference to condensing, working expansively, or even clothing the boilers or pipes.

The coal used is of course principally bituminous. The heating furnaces use the same, mixed with anthracite, without seriously affecting the steam-generating qualities of the flame. It is, nevertheless, pretty generally conceded, that those boilers connected with the puddling furnaces are sensibly the most efficient, and the value of waste heat from furnaces under different circumstances and with different fuels might be worthy of testing on a large scale by a series of long-continued and careful observations, the entire absence of cost either for fuel or firemen in obtaining power from this source offering a most inviting field for enterprise in this direction.

Prominent among the improvements which Mr. Winslow has introduced in the various departments of his business stands the machine for compressing the balls from the puddling furnaces, already alluded to as the Patent Squeezer. This machine is illustrated in Appletons' Dictionary, vol. ii., p. 491, and in Byrne's Practical Metal Worker, published by H. C. Baird, p. 22. The practical advantages of this machine are briefly summed up by affirming that one machine will do all the shingling for 25 puddling furnaces with but a trifle of expense for attendance, little or no expense for repairs, a small consumption of power, no waste of iron, and turning out the blooms very hot it very much facilitates the rolling. This preservation of the heat, coupled with the fact that the bloom is very thoroughly upset while undergoing its rapid squeezing, is considered by many to sensibly improve the quality of the iron. The car axles from this establishment, made from charcoal iron several times worked over, and finally inclosed in scrap, are smoothly finished under a stream of water under the hammer, every axle being carefully examined and marked with the maker's name, or rejected if in the least degree imperfect.

We cannot well conclude this sketch without alluding to the example presented by the proprietors of these works in relation to their employees, after the calamity of the 27th June. The rents of their dwellings were immediately suspended, and employment was offered to all as assistants in rebuilding. In addition to this, temporary engagement for many was procured abroad, so that the sudden and unexpected stoppage of works involving the whole support of bewteen 400 and 500 hands, which under the usual circumstances would be a most serious disaster, was in this case scarcely felt.—D.

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Allen and Wells' Adjustable Cut-Off.

(See Plate.)

This improvement in valve geering for puppet valves, invented by Horatio Allen and D. G. Wells, of the Novelty Iron Works, is the simplification of the arrangement of valve geering patented by Horatio Allen in 1849, and the introduction of a new and exceedingly ingenious method of working the loose toes, the invention of Mr. Wells. In the form patented in 1849, the cut-off has been in use on board the Northerner, Cherokee, Tennessee, Franklin, Hermann, Humboldt, Oregon, California, Alabama, Florida, Atlantic, Arctic, and other ocean steamers, to the entire satisfaction of all parties interested. In the form now presented, it is in use on the ferry-boats California, Martha, Shampisbuh, City of Williamsburgh, and ocean steamer State of Georgia, and has worked perfectly, and excited much admiration in the mechanical world.

Figs. 1, 2, 3, and 4, are views of the improvement. $a\ a$ are the side pipes placed in the usual positions; b is the rock shaft, placed in the same plane with the valve-rods, and worked by an ordinary excentric attached to the pin y; $c\,d$ are the steam valve-rods; $e\,f$ are the exhaust valve-rods; $o'\ o''$ are the exhaust valve-toes which, through the lifters $i\,k$, operate the exhaust valves in the usual way; $p\,p'$ are loose toes supported on the rock shaft, and which operate the steam valves through the lifters $g\,h$; o''' is an arm permanently attached to the rock shaft, and carries the rollers $x\,x'$, which rollers will of course have the same motion as the rock shaft.

In Fig. 3 will be seen two curved pieces or *palls* $q\,q'$, connected to the outer ends of the loose toes by pins, on which they are free to vibrate. The lower ends of the palls rest at the commencement of their upward motion against the rollers $x\,x'$, as shown in the pall q', Fig. 3; but the surface by which it rests against the roller x', is an inclined one, and unless kept from sliding in towards the rock shaft, the toe p' would not be raised when motion was given to the arm o'''.

To provide for the control of the palls, there is placed loose on the rock shaft the arm r, which carries the two rollers $w\ w'$ by means of the right and left hand screw s; this arm has a motion nearly coincident with that of the piston, communicated by suitable means through the pin z. The position of the rollers $w\,w'$ is such that at the beginning of the stroke, when the inclined end of the pall q' rests against the roller x', the upper surface of the pall will rest against the roller w', and as long as the roller w' is in contact with the upper surface of the pall, the pall must have the same motion as the arm o'''. The upper surface of the pall is circular, and in its extreme outward position, the centre of its circular surface is the centre of the rock shaft.

The parts described being adjusted as represented in Fig. 3, and put in motion, the arm o''' carrying the roller x' will carry up the pall q' and lift the toe p', and thus, by means of the lifter h and the stem d, raise the steam valve resting on it. The pall q' would continue to receive its motion from the roller x' as long as the roller w' keeps it in its extreme outward position; but as soon as the roller w', in its motion downward, passes the lower end of the pall q', the lower end of the pall will slide in towards the rock shaft, and will soon be only held by the roller w', and as the motion of this roller is downward, the pall will no longer be raised, but will be lowered with whatever velocity the roller may have.

The point at which the pall will be disengaged from the upward action of the roller x', will depend on the position of the roller w'. This adjustment of the two rollers $w\,w'$ forms the adjustable feature of the cut-off, and is effected by placing each roller on an arm $t\,t'$, which are connected with the arm r by the right and left screw; by turning the screw in one direction the arms carrying the rollers $w\,w'$ will be separated, and by turning it in the other direction they will be brought towards each other, thus regulating the time when the valve, descending by the motion of the arm r, will arrive at its seat.

To provide the means of working the engine by hand, there is placed on the rock shaft the piece m, which is free to move round the rock shaft; on this piece are short projecting toes, one under each of the lifters of the valve stems, also a socket for the starting bar. The piece m, when worked in one direction, will raise the steam and exhaust for the up stroke, by means of the projections $n\ n$ on the lifters, and when worked in the other direction will raise them for the down stroke.

This arrangement of the cut-off is exceedingly simple and compact, yet perfectly adjustable to any part of the stroke of the engine while in motion. It dispenses with the ordinary lifting-rods, thus leaving more room in front of the engine, and all the parts being supported on the rock shaft are under the immediate eye of the engineer. The side pipes form the bearings for the rock shaft, by having a pipe cast through them, which is bored to the appropriate size.

◆

Patent Cases.—Woodworth Planing-Machine.*

Sloat vs. *Patton.* *Sloat* vs. *Winslow.* *Wilson* vs. *Sumeden.* *Wilson* vs. *Ashton.—Motions for Special Injunctions.*

Before Hon. John K. Kane, holding Circuit Court for Eastern District of Pennsylvania.

These were four cases in equity heard during the April Sessions of the Court, on bills and affidavits upon application for special injunctions. The complainants in the several bills were the assignees of the exclusive right to use the planing-machine of William Woodworth, for the extended term of the patent, within the County of Philadelphia.

The infringement complained of in the first of the above suits, Sloat *vs.* Patton, was alleged to consist in the use of a planing-wheel of a nearly disk form, slightly inclined in its plane of revolution to the plane of the board to be operated upon. The planing-knives were so placed in this wheel, that when it revolved the edge of those knives generated the surface of an obtuse cone. It was stated by the complainant, that the board to be planed was controlled by pressure upon its surface by means equivalent to those described in Woodworth's Patent; that this defendant thus employed a combination of pressure rollers with rotating knives, substantially the same as described in the Woodworth Patent. It was further alleged that the machinery employed by this defendant to tongue and groove the boards was an infraction of another claim of the same patent. This machinery consisted of elliptical saws or plates, placed on vertical axles in an inclined position to such axles, so that the teeth of these elliptical saws or plates would describe the convex surface of a cylinder when the plates were revolved. It was further said that the means of controlling the board, while under the action of the tonguing and grooving wheels, were analogous to those patented.

The Court declined hearing argument from the defendant on the validity of the Woodworth Patent at this stage, referring to previous trials and investigations in that Court as having determined that question. The defendant denied that the machines used by him infringed upon any claim of the complainant's patent. He asserted and read affidavits to establish the fact, that the planing-wheel employed by him was a simple disk, and described in its revolution a plane parallel with the face of the board, and not the surface of a cone. He said that in his machine pressure to control the board was neither used, nor required to be used. His tonguing and grooving tools, he insisted, were entirely unlike in form and principle of operation to the cutters of Woodworth. Many affidavits of a contradictory character were read on both sides, and Professor Byrne was examined orally on behalf of the defendant, and Harvey Waters on behalf of the complainants.

The machines used by Winslow and by Ashton, the defendants in the second and fourth of the above suits, it was alleged by the complainants, bore a still closer resemblance to those patented by Woodworth. It was contended that the tonguing and grooving apparatus in these machines was identical with that of Woodworth, and that the planing-wheels employed by these defendants were so placed as to describe a more clearly perceptible cone than in Patton's machine.

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* From the Journal of the Franklin Institute.

Fig 1

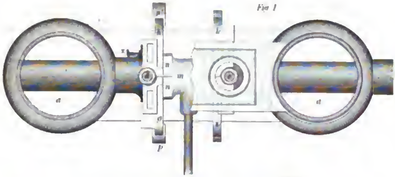


Fig 4

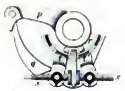


Fig 2.

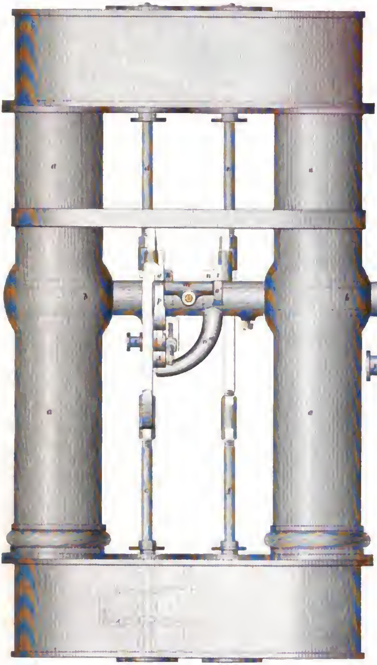
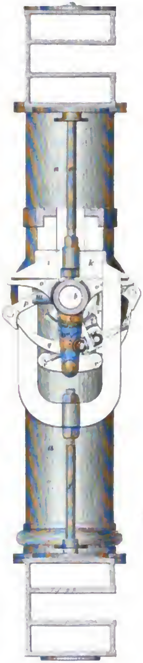


Fig 3



ALLEN & WELLS' ADJUSTABLE CUT OFF.

Drawn by T.D. Stetson

For Poppet Valve Engines.

On behalf of these defendants, it was admitted that the tonguing and grooving tools were similar to those of Woodworth; but it was insisted that the planing-wheel did not describe a conical surface, and that pressure was neither required nor used while the board was being planed.

Two bills had been filed against Snowden, the defendant in the third suit,—one was filed by J. P. Wilson, as assignee of the Woodworth patent, and the other by J. P. Wilson, as assignee of the Barnum planing-machine patent. It was complained that Snowden infringed on the Barnum patent, by using the precise machine described and patented by Barnum for planing; and that he infringed on the Woodworth patent by using the same tools and combination in tonguing and grooving as were described therein. The latter infringement was not denied by the defendant during the argument, but it was contended that the defendant had acquired a right to use the Barnum machine, by virtue of a license from Barnum, the former owner of the patent, and subsequently it was contended that he had acquired this right by the purchase of a machine from Barnum. The complainant denied that any valid title was acquired by Snowden in either manner as alleged.

During the course of the evidence, affidavits stating that the complainants had been unable to obtain access to examine the respective defendants' machines were read, and application was made to the Court for an order of inspection. Whereupon the following order was made:

"That the respective defendants do permit an inspection and thorough examination by Harvey Waters, on behalf of the complainants in the above cases, of the planing, tonguing, and grooving machines in controversy, in each case respectively, and that the said expert be permitted to bring any specimens of the work done by the said machines; and that the said machines shall be worked by the servants of the respective defendants as the said Harvey Waters may request."

Mr. Waters afterwards was examined in Court as an expert, and exhibited specimens of boards planed at the several machines. In the course of the trial, a very ingenious working model of a planing-machine was introduced into Court by the last-named expert. Its essential feature was a Woodworth planing cylinder, so constructed and arranged that while the operation of planing was going on, this cylinder could be altered to a cone or to a disk, and vice versa.

The four cases were argued at the same time. Mr. Campbell, Mr. Keller, and Mr. Harding appeared for all the complainants, and Mr. Cuyler appeared for all the defendants. Mr. Hubbell also appeared for Patton, and Mr. Taylor for Winslow.

The Court, having taken time to consider, delivered the following opinion on the 28th of May last, granting injunctions in all the cases as prayed for.

OPINION.

The effort to smooth boards and reduce them to a uniform thickness by the rotary action of cutter knives set in the face of a disk, and made to revolve in the plane of the intended surface, is of ancient date. But from the time of Bramah, half a century ago, until now, it has never been successful.

If it were practicable to construct a machine, mathematically accurate in all its parts, and of inflexible material, so as to prevent all possible vibration; and if, besides, the wood to be operated on could be first deprived of all its elasticity, then each cutter as it passed on its way, removing a certain portion of the board, would leave the surface absolutely finished behind it—and the other cutters and the same cutter returning in its revolution, all following in absolutely the same plane with the first, would pass over the finished surface, neither abrading it nor compressing it, yet in contact with it.

But these conditions involve mechanical impossibilities. The strongest engine that ever came from the shops, vibrates sensibly when it encounters an intermitting resistance, and there is no such thing as a non-elastic. The practical consequence is, that the cutters after finishing their work, still continuing to revolve over the smoothed surface, will sometimes be impelled for the instant below the plane of their normal action; and, on the other hand, the board partially compressed when under the action of each cutter in succession, but rising again immediately afterwards by its own elastic force, will present a new surface to be acted on by the next cutter—that surface varying in height according to the varying density and consequent elasticity of the board. This is illustrated by the *back-lash*, an irregular trace made on the finished surface by the cutters that continue to pass over it.

Woodworth was the first to propose a remedy for this, by placing his cutters on the periphery of a rotating cylinder, while he presented the face of the board in the tangent plane of their revolution. He thus prevented the cutters, while the board was moving, from tracing it a second time, and gave the *dip and lift cut* which has been so often recognized as the characteristic of his patented machine.

It is obvious that to make this cut, it is not necessary to place the cutters on a true cylinder. A cone, or even a dished wheel, scarcely deviating in appearance from a true disk, will produce the same effect, provided the board approaches and leaves the cutters in the tangent plane of their revolution. I had no difficulty, therefore, when the cases of Plympton and Mercer and others were before me, some years ago, in holding that a cone or dished wheel so arranged, was simply a mechanical equivalent for the cylinder of Woodworth; and the rulings then made have, on more than one occasion since, received the sanction of both the judges of this Court.

Strange to say, in three of the cases now before me, the principal dispute has been as to the fact, whether the machine used by the defendants is or is not a *disk*, or, as it has been spoken of in the argument, a Bramah wheel. Numerous witnesses, some of them highly respectable, have testified that it is nothing else—and that its cutters move of course in the same plane, and parallel with the lower face of the board—in other words, that the cutting disk coincides in its revolutions with the finished surface. But it is as certain as any truth in the philosophy of mechanics, that in this they are mistaken—for the machine in its ordinary working leaves no back-lash, and the boards that were passed through it by one of the gentlemen who inspected it under the Court's order, show unequivocal marks of the dip and lift cut.

Neither witness nor counsel has explained how a disk, which all describe to be like Bramah's wheel, and worked as his was, can produce results so different from his; nor how it happens that the results produced by it are so precisely those which would be produced by cutters revolving on a flattened cone. On the contrary, all admit that the machine does vibrate, and that the boards which it commonly works on are damp, if not wet, and of course easily compressed under the cutters. It is to exact more than a reasoning faith in human testimony, to assure us that such a machine acting on such a material, will, in the hands of the defendants, renounce the mechanical law which it has been exemplifying everywhere else for the last fifty years.

It is true, that upon *tramming* the disk with the bed-plate, in order to test their parallelism, the defendant's witnesses observed *no* deviation from the disk form. But though this were so, yet in just such a disk the cutters might be arranged in such a manner as to describe a cone when revolving; and Mr. Patton's cutters were not, and probably could not be trammed. Besides which, the axis of the disk was so adjusted at its upper extremity, as to give it at pleasure the oblique action which is adapted to the revolving cone, and yet to restore it again in a few minutes, with the disk parallel to the bed-plates.

When we consider that the machine while at rest can have its character thus easily modified, so as to give proof for the time of the parallelism of its parts, if such proof be desirable, and that while in motion, it defies all scrutiny, revolving, it may be, some 3000 times in a minute, and its three cutters therefore following each other with an interval between them of but the 150th part of a second; and that an obliquity in the disk, not exceeding the $\frac{1}{16}$th of an inch on its cutting diameter, would be sufficient to change its effective action; we can apprehend without difficulty that the defendant's witness may have fallen, very honestly, into error. But it is enough for us to know, that according to the laws of matter and motion, which are the condensed expression of all mechanical experience, the machine, as they describe it, cannot produce the effects, which we see that the machine produces in fact. The footprint on the sand indicates with less certainty the form and pressure of the foot that made it, than a curved cut on the face of a flat board proves a corresponding curvature in the path of the cutting tool.

It is in vain to refer us for an explanation to the abnormal influences of vibratory or semi-elastic forces, without showing us what those influences are, and how they resolve—they resolve for the time a disk into a cone, or enable the machinist to trace a regulated curvilinear surface by the rectilinear movement of a plane. This is only to reassert the paradox in more general language, to prove the controverted fact by reference to an unknown theory.

I must hold, therefore, that the planing-machine of Messrs. Patton, Ashton & Winslow, and Ashton & Beer, are essentially the same with the planing apparatus of the Woodworth patent.

The machine employed by Mr. Patton, and, as it is said, invented by him, for cutting the tongue and groove, is spoken of as an elliptical saw. It consists of a revolving saw-plate of lozenge shape, set at such an oblique angle as to make all the teeth on its periphery equidistant from its action of motion. In revolving, it describes, of course, a cylinder, and its action is that of a rasp. It does not divide the board as a saw does; but performs the office of Woodworth's duck-bill cutter, somewhat less perfectly, and apparently at greater cost. The only points of difference are, that what would be the one cutter of Woodworth is, in Mr. Patton's machine, effectively divided into several, so as to form a series of cutting disks or saws, the teeth of which abrade in succession the portions of the board to be removed, leaving the edges rough in consequence, instead of giving them the comparatively smooth surface of the Woodworth machine; and that while a broken cutter can be removed from the Woodworth disk, and a new one substituted, a tooth broken from Mr. Patton's saw destroys it. Whatever, therefore, may be the supposed interest or novelty of the elliptical saw, it must in its adaptation to this particular use, be regarded as embodying the principle, and constituting, but for its inferiority, the mechanical equivalent of Woodworth's cutting-wheel.

The tonguing and grooving apparatus of the Ashton and Winslow, and Ashton and Beer machines, are confessedly those of Woodworth's patent.

The same is true of Snowden's; and his planing-machine is an equally direct piracy of the Barnum patent, now held by the complainant.

I have not, in this opinion, discussed the question of the validity or the extent of Woodworth's patent. These have been so often before almost all the Courts of the United States, as to make them inappropriate topics for interlocutory argument. There must be at some time or other an end of controversy as to the character of a patentee's property in his invention; and now that twenty-three years have gone by since the Woodworth patent was issued and passed into litigation, I am disposed to recognize its parting claim to repose; *solve senescentem.* I therefore limited the discussion at its outset to the single question of infringement.

I have one more remark to make, it is prompted by a review of the devices employed by these defendants and those who have gone before them in similar controversies. I cannot but think that the time has come, when, in this District, at least, the attempt to mask an infringement of this particular patent should be almost regarded as a waste of ingenuity. It is a truth of large acceptation, both in policy and morals, that it is better in the long run to strive patiently for a legal property of one's own, than to persist in trespassing on the property of others. The invention which is set forth in letters-patent *belongs* to the inventor—as rightfully as the house he has built or the coat he wears. It cannot detract from the dignity of his title, that the subject of it is of his own creation, his thought conceived and developed and matured in the recesses of his mind, that it has cost no man else any thing, and asks nothing in return for the contribution it makes to the general wealth and happiness, but that security of enjoyment, during a limited period, which the laws engage for all other property without limitation of time, and without stipulating a price. It would be a reproach to the judicial system, if an ownership of this sort could be violated profitably or with impunity.

The complainant's counsel will prepare the draft of decretal orders in the several cases in accordance with this opinion.

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Steam and Locomotion.*

BY JOHN SEWELL, L. E.

Combustion.—Oxygen.—Hydrogen.—Nitrogen.—Carbon.—Carbonic Acid Gas—Carbonic Oxide.—Comparative heat from various fuels.—Application of heat to produce Steam or Evaporation.—Theories of Heat.

Atmosphere.—This important body which surrounds us, and supplies the oxygen, or *life* of our breath, besides its other invaluable features, is a mechanical mixture of one-fifth part of oxygen and four-fifth parts of nitrogen, sometimes called azote. The latter dilutes the former, and renders it adapted to the constitution of man and the animal creation; and but for this dilution of the oxygen by the nitrogen, constituted as we are, life would be an accelerated but short course, similar to the brilliance exhibited by a wax taper when plunged into a jar of oxygen on the lecture table. Oxygen is therefore the principal supporter of both life and combustion; but the peculiar uses of nitrogen are only clearly understood as indispensable to vegetation. An ordinary iron furnace is estimated to require 310 tons of air in 24 hours, or as much as 20,000 men. That it is the oxygen which changes or supports ordinary combustion may be shown by covering an ordinary candle with a bell glass whose lower edge rests in water, to prevent a further supply of air inside the glass. As the inclosed oxygen is changed the flame grows less and less until it is extinguished, and the contents are found to be nitrogen apparently unaltered, hydrogen and carbonic acid. 100 cubic inches of air weigh 31 grains.

Oxygen.—This gas was discovered by Dr. Priestley in 1774, and is considered to be one of the most abundant bodies in nature. It is a permanent colorless transparent gas without smell, and 1·11 times heavier than air, and 100 cubic inches weigh 34·184 grains. It combines with many other bodies in a variety of ways, forming very distinctive compounds. For ordinary combustion and breathing it is supplied from the atmosphere, but for the lecture-room it can be readily obtained in several ways, one of which is by heating the chlorate of potash, and collecting the gas given off in a bladder or jar. If a taper with a single spark of fire left on its wick be placed in any jar of oxygen, it immediately burns forth with splendor, and iron when introduced is melted down in a shower of dazzling scintillations, forming oxide of iron.

Ordinary rust is also oxide of iron formed from the slow combustion of atmospheric temperature, whilst the intense temperature of carbon and pure oxygen produce rapid combustion, and the smith's forge is only another degree of the same process. Phosphorus introduced amongst oxygen produces a volume of painfully brilliant light forming phosphoric acid.

The oxy-hydrogen light, as invented by Mr. Gurney, improved by Mr. Beechy, and exhibited by Mr. Abraham of Liverpool in the Great Exhibition, consists in bringing equivalent quantities of oxygen and hydrogen gases into a burner and igniting them, when they evolve vivid combustion and intense heat, melting all common metals with great ease. Lime, however, resists its fusive power, but evolves the most brilliant light then known, which is employed in the Polytechnic Institution for their microscopic views. Recently, however, a still more luminous light is produced by the action of electricity on two pieces of charcoal, and M. Lessel and Co. exhibit one of great illuminating power at the Crystal Palace, whose light when tried by the prism shows the solar spectrum rays of the light of the sun, viz., red, orange, yellow, green, blue, indigo, and violet.

Nitrogen.—This body neither supports life nor combustion. It is lighter than air, has no taste or smell, is little absorbed by water, and has no effect upon lime-water. Its specific gravity is ·972 that of air, or 100 cubic inches weigh 30·15 grains. Although nitrogen has some properties in common with carbonic acid, one of the products of perfect combustion, it has also dissimilar ones, besides being an elementary body, while carbonic acid is a compound of oxygen and carbon. Nitrogen is necessary to life. Carbonic acid is poisonous. Protoxide of nitrogen forms the well-known laughing gas, which produces such an exhilarating flow of spirits and muscular energy, by a few inhalations of it, and its specific gravity is 1·527 that of air, or 100 cubic inches = 47·37 grains.

Carbon.—This is a finely-divided pulverulent mineral body in its ordinary state, forming the basis of most fuels, and found in many different forms; as it is obtained by various processes—from oil lamps, as lamp-black; from coal, as coke; and from wood, as charcoal. It is the mineral particles of carbon in a state of combustion which render flame luminous from either gas, oil, or candles. Tallow or wax candles are a compound of carbon, oxygen, and hydrogen. The diamond is pure carbon in a crystalline state, possessing the singular property of reflecting all the light which falls upon it at an angle of about 24°, whilst artificial gems only reflect half that light. The diamond is highly valued, and in much esteem as an article of dress, or to adorn an imperial crown. Amongst the many attractions of the National Exhibition, her gracious Majesty's three specimens of pure carbon in the celebrated Koh-i-noor and two other diamonds, are none of the least.

To the general reader the following particulars of the "Mountain of light," (Koh-i-noor) may possess interest.

The Koh-i-noor has no ordinary history, having frequently changed owners, either by the fortunes of war or intrigue, and is now little more than a third of its original weight, being reduced by the unskilfulness of Hortense Berghere, a Venetian lapidary, from 800 to 279 carats. Its original value was estimated at 3½ millions; it is now estimated at only half a million, for diamonds rapidly increase in value with size. It first received notice when belonging to the Mogul princes, and was obtained by Nadir Shah when he plundered Delhi, to the extent, it is said, of 40,000,000*l*. On his assassination it disappeared for a time, until Ahmed Shah's time, and it passed from his successor, Shah Soojah, to Runjeet Singh, on whose death it remained at Lahore until it was taken by the British during the last Sikh war.

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* From a treatise published by John Weale, London, entitled Rudimentary and Elementary Treatise on Steam and Locomotion.

and is now exhibited in Great Britain's Industrial Palace. It is not now the largest diamond known, although originally it was so, as that of the Rajah of Mattan in India weighs 367 carats, or 3 ounces troy. A few other celebrated pieces of crystallized carbon are, the Empress of Russia's, weighing 193 carats, and valued at 90,000*l.*, the Emperor of Austria's, weighing 139 carats, valued at 100,000*l.*, and the Orleans or Pitt diamond, weighing 136 carats, and valued at 164,000*l.*

Such are the values of small pieces of carbon, as found in the diamond, but intrinsically, for national wealth, they will not bear an instant's comparison with that form of carbon which composes from 60 to 90 per cent. of coals. The former is an absorber of wealth otherwise existing; the latter is a producer of wealth throughout the world, and in this country forms the basis of our power and progress, without which the Crystal Palace had not been called into existence.

Carbon also unites with iron to form steel, and with hydrogen to form the common street gas, called carburetted hydrogen gas. Analysts tell us that the diamond and its converse, lamp-black, are both pure carbon; and charcoal and coke are other well-known forms of carbon, obtained by burning them with a partial supply of air or oxygen. Coals are a compound of carbon, hydrogen, nitrogen, and oxygen. Carbon is considered as the next most abundant body in nature to oxygen. In the furnace the carbon of the fuel unites with the oxygen of the air to produce heat. If the supply of air is correctly regulated there will be perfect combustion producing carbonic acid, but if the supply of air be deficient, combustion will be imperfect, and carbonic oxide produced.

Carbonic Acid Gas.—When air passes through a fire, this gas is formed by the combustion of 16 parts of oxygen and 6 parts of carbon. Its specific gravity is 1·523 that of air, and it forms 44 per cent. of lime. It is fatal to life, as exemplified in the black hole of Calcutta, when about 140 men died in one night by breathing the same air again and again until the oxygen in it had become this gas. It also extinguishes fire, as has been so ably shown this year by Mr. Gurney, forcing it into the burning Sauchie coal-mine, and putting out a fire of about 26 acres area and 30 years duration.

Carbonic Oxide.—This is a colorless, transparent, combustible gas, which burns with a pale blue flame, as may be seen at times on opening a locomotive fire-box door. Its presence in a furnace is evidence of imperfect combustion, from a deficient supply of air, as it indicates that only 8 parts of oxygen instead of 16 parts have united with 6 parts of carbon, requiring as much more to produce complete combustion.

Hydrogen.—Hydrogen is the source of all common flame, although it extinguishes a light plunged into it, but in doing so takes fire itself and burns at the edge of the vessel, similar to its issuing from a gas burner, when it combines with the oxygen of the air and gives out a brilliant flame, but does not enter into the tube or burner where the air is not in contact to supply the necessary oxygen.

It is the lightest known body in nature, being 16 times lighter, for equal volumes, than oxygen, and is a permanent, yet combustible gas, giving out much heat. It was discovered by Cavendish in 1766, and being 14½ times lighter than air, it is employed in balloons. In our gas establishments it is now distilled from coal in large quantities and combined with carbon for illuminating streets, shops, and dwelling-houses. It is not itself innoxious to life, but does not support it, and when combined with sulphur, it becomes explosive, and too frequently produces the most lamentable results in our coal mines. By passing a current of steam through a hot iron tube partly filled with filings, hydrogen gas is given off, and burns with a pale yellow flame. It also combines with oxygen to form water according to Watt's composition of that body. But the recent experiments of Payne seem to indicate that water may be decomposed by negative electricity into hydrogen, and by positive electricity into oxygen; and by both poles being applied, both hydrogen and oxygen are produced from the water, as ordinarily decomposed.

Comparative Heat of Carbon and Hydrogen.—Dulong estimates that 1 lb. of hydrogen will give out about 4·707 times as much heat as 1 lb. of carbon. In ordinary combustion there is rarely found any provision made to effectually consume the hydrogen evolved in the furnace, so that it has been usual to take the quantity of carbon in any coals or coke as the index of their heating powers. If hydrogen gas come to be cheaply evolved, or furnaces arranged to partly consume what is evolved, the theoretical and practical duty of fuel would be proportionally increased. If a unit of heat be taken as the quantity which would raise 1 lb of water 1° Fah., 1 lb. of carbon is valued as equal to 13268 such units, and 1 lb. of hydrogen as equal to 62470 units, or 4·7 to 1 of carbon. In ordinary coal fires of engines the air is only admitted by the fire-grate, and after passing through the fire, is consequently unfitted to totally consume the hydrogen gas evolved, which may thus pass off as lost heat, and what portion may be consumed will scarcely balance the heat necessary to its production.

Heat from Combustion.—This is variously estimated by different authorities. Despretz gives the following values on lbs. of water raised 180° by 1 lb. of each fuel.

1 lb. of		Lbs. of water from 32° to 212°
Hydrogen	heat	236·4
Olive oil	"	90 to 95
Ether	"	80
Pure charcoal	"	78
Wood charcoal	"	75
Alcohol	"	67·5
Coals	"	60
Baked wood	"	36

Process of Combustion in a Furnace.—For raising steam, the process of combustion consists in evolving and completely consuming the combustible elements of either coal, coke, or other fuel employed, to produce heat, which may be divided into four different stages of the process:

First stage.—Application of existing heat to evolve the constituent gases of the fuel. In coals this is principally carburetted hydrogen.

Second part.—Application or employment of existing heat to separate the carbon from the hydrogen.

Third part.—Further employment of existing heat to increase the temperature of the two evolved combustibles, carbon and hydrogen, until they reach the heat necessary for combination with the oxygen of the air. If this heat is not obtained, chemical union does not take place, and combustion is imperfect.

Fourth and last part.—The union of the oxygen of the air with the carbon and hydrogen of the furnace in their proper equivalents, when intense heat is generated by the exchange of the electrical heat in each, and light is also given off from the ignited carbon. Sir H. Davy estimated this heat as greater than the white-heat of metals.

In the first three stages of combustion heat is absorbed by the fuel, and only in the last stage of the process is that absorption replaced with greatly increased effects.

When the chemical atoms of heat are not united in their proper equivalents, then carbonic oxide, carburetted hydrogen, and other combustible gases escape invisibly, with a corresponding loss of heat from the fuel. When the proper union takes place, then only steam, carbonic acid, and nitrogen escape, which, being the products of perfect combustion, are all incombustible, and also incapable of supporting combustion.

The principal products, therefore, of perfect combustion are:

Steam,	invisible and incombustible.
Carbonic acid,	Invisible and incombustible.

The products of imperfect combustion are:

Carbonic oxide,	invisible but combustible.
Smoke,	partly invisible and partly Incombustible.

Steam is formed from the hydrogen gas given out by the coals combining with its equivalent of oxygen from the air, in the ratio of two volumes of hydrogen to one of oxygen, or by weight as one to eight, as already explained.

Carbonic acid is formed from the carbon of the coals combining with its equivalent of oxygen from the air, in the proportion of two volumes of oxygen to one volume of carbon, or by weight, as sixteen to six.

Carbonic oxide is formed from the carbonic acid first produced, receiving another volume of carbon in passing through the fire, which last volume of carbon is unconsumed, and forms the combustible carbonic oxide, whilst carbonic acid, having had its carbon consumed, is incombustible.

Smoke is formed from the hydrogen and carbon which have not received their respective equivalents of oxygen from the air, and thus pass off unconsumed. The color of the smoke depends upon the carbon passing off in its dark pulverized state, but the quantity of heat carried away is not dependent upon the carbon alone, but also upon the invisible but combustible gases (hydrogen and carbonic oxide), so that whilst the color may indicate the amount of carbon in the smoke, it does not indicate the amount of heat lost; hence the smokeless locomotive may, and does unobservedly lose more heat in this way than is lost from the combustion of coals in stationary-engine furnaces.

Besides the demands of the carbon for the oxygen admitted to the furnace, the hydrogen evolved also requires its equivalent, and could this be fairly carried out in the locomotive furnace, the oxy-hydrogen light is sufficient evidence of the intense heat which would be obtained. But where there is no provision for the proper supply of oxygen to such gases, it is evident that the hydrogen evolved must nearly all pass off unconsumed.

The hydrogen requires one equivalent to produce steam, and the carbon another equivalent to produce carbonic acid. Along with these two equivalents of oxygen, the air contains eight equivalents of nitrogen (of no known use in combustion), also passing through the furnace, consequently requiring ten times as much air as there are gases to be consumed. When less than the proper quantity of air is supplied, hydrogen, from its greater affinity for oxygen than carbon, will take up its equivalent for steam, leaving the carbon to pass off partly unconsumed, as carbonic oxide. An excess of air is, however, as injurious by its tendency to lower the temperature of the evolved gases below the point where the chemical union takes place, and requires to be guarded against in the well-arranged and well-managed fire-place.

A practical and familiar instance of imperfect combustion is exhibited when a lamp smokes, and the unconsumed carbon is deposited in "blacks" all round it. When the evolution of carbon is lessened by lowering the wick to meet the supply of oxygen, the carbon is all consumed and the smoke ceases. What takes place with a lamp also occurs in a furnace, so that the proper supply of air is a primary consideration, both as regards its quantity, and its mode of admission to a fire; for both affect the economical results.

In locomotive furnaces for coke, the air is usually admitted through the fire-grate, and before it passes through a thick body of red-hot fuel, the oxygen is either all absorbed or so deteriorated, that it is incapable of combining with the hydrogen, which thus passes off unconsumed, and may be occasionally observed to ignite at the top of a locomotive chimney, when it obtains its equivalent of oxygen from the surrounding atmosphere. Such ignition of course only takes place when the steam is shut off, as its condensation saturates or cools the gases below the temperature of chemical union.

The economical generation of heat is therefore a process entirely distinct from the use made of that heat afterwards, just as the generation of steam is an entirely different question from its employment in an engine.

Combustion may be perfect, but absorption of heat by a boiler may be inferior, and consequently evaporation of water bears a low ratio to the fuel consumed. To arrange the construction of a boiler with rapidly absorbing materials is the principle aimed at by our best boiler-makers, to obtain increased evaporative power.

The human body has been frequently compared to a furnace, and the process of digestion to combustion, and it is a correct description, for oxygen is the active agent in both processes. In placing animal food in a red-hot platinum crucible, its carbon unites with oxygen to form carbonic acid; its hydrogen with oxygen to form water; its nitrogen either escapes free, or unites with hydrogen to form ammonia, leaving behind only some salts partly soluble and partly insoluble in water.

Now, in the living animal frame these processes are in regular operation.

The food is the fuel, evolving carbon and hydrogen, which, combining with the oxygen inhaled by the lungs from the air, is burnt, and the products of combustion, steam and carbonic acid, are exhaled from the lungs. As in the experiment with the inclosed candle, so in the human body, the nitrogen of the air appears to be inhaled and exhaled without apparent alteration. The nitrogen and soluble mineral portions of the food pass off as salts of ammonia in the urine, and the insoluble portions or "clinkers" of the food require, as is well known, especially to those suffering from dyspepsia, to be as regularly cleared off as do the residue from the fire-grate.

Sir H. Davy found that he required for respiration during 24 hours, 45,504 cubic inches, or 15,751 grains of oxygen, which produced 31,680 cubic inches, or 17,811 grains of carbonic acid, of which 4853 grains were carbon. Since oxygen is only $\frac{1}{5}$ of the air, the volume of air inhaled would be 45,504 × 5 = 227,520 cubic inches in 24 hours. The mean carbon issuing from the lungs of an ordinary-sized man is about 130 grains per hour, or rather more than 7 ounces daily, besides what passes off by cutaneous perspiration. In a state of repose, however, Savaser found that the consumption of oxygen was only $\frac{7}{12}$ that of a state of activity: hence sleep is known to be "tired nature's sweet restorer," by its then allowing the human furnace a little rest; for it is a law, that rapid combustion is equally fatal to the iron and to the vital furnace.

The average quantity of air inhaled at once by a man is about 20 cubic inches, and as one-fifth of it again leaves the lungs in a poisonous state (carbonic acid) it vitiates any confined atmosphere unless ventilation steps in to prevent injurious consequences more or less rapid—as the supply of air may be more or less imperfect.

The animal heat of combustion is about 98° Fah., and is of course slow compared to an iron furnace of 3479° Fah.; still both processes are chemically alike, and pure air is as needful a supply to the human furnace as it is an indispensable one to the locomotive furnace.

The following table of the temperature of combustion in man and other living species may be instructive.

TABLE NO. 1.—*Heat of Combustion in the Living Furnace.*

Class.	Temp. of Atmos. Fah.	Temp. of Animal. Fah.	Class.	Temp. of Atmos. Fah.	Temp. of Animal. Fah.
Man . .	Various.	98	Crow . .	67	104
Monkey .	86	102	Frog . .	76	77
Hare . .	80	100	Green Serpent	$81\frac{1}{2}$	$88\frac{1}{2}$
Tiger . .	80	100	Brown ditto	$82\frac{1}{2}$	$84\frac{1}{2}$
Dog . .	80	102	Brown Adder	$82\frac{1}{2}$	90
Cat . .	77	102	Shark . .	74	77
Horse .	79	101	Trout .	$55\frac{1}{4}$	$57\frac{1}{2}$
Ox . .	79	102	Flying Fish	$77\frac{1}{2}$	$77\frac{3}{4}$
Kite .	80	100	Oyster . .	81	81
Sparrow	80	108	Lobster .	$79\frac{1}{4}$	79
Pigeon .	78	109	Crab . .	72	72
Hen .	78	110	Beetle .	76	77
Goose .	78	106	Glow-worm	72	$73\frac{1}{2}$
Drake .	78	110	Wasp .	$74\frac{1}{2}$	76

The temperature of the animal body appears to be regulated by its own internal combustion without reference to the surrounding medium. For instance, man is found to possess the same heat under all climes and temperatures supportable by the human body.

It is estimated that the heat given off by the human body in 24 hours would raise 63 lbs. of water from the freezing to the boiling point, yet the carbon thrown off from the lungs is estimated as only equal to heat $36\frac{3}{4}$ lbs. of water, through the same range. The difference is supposed to be due to the action of the muscles and the nerves.

Application of Heat to produce Steam or Evaporation.—The comparative effect of heat to produce steam in a boiler depends upon the ratio of the absorbing and transmitting power to the velocity of the escaping products of combustion. For if the velocity be greater than the absorption and transmission of the passing heat to the water, then there will be a corresponding loss of heat. In the locomotive boiler with a rapidly escaping current only from $\frac{1}{18}$ to $\frac{1}{16}$ of the absorbing surface is by direct contact at ordinary speeds of the engine, and the remainder at right angles to the escaping current of heat. At high velocities the surface of contact will be increased to about $\frac{1}{3}$ or $\frac{1}{2}$, whilst the velocity of the escaping gases will be also increased, over a decreased length of tubes. Therefore as the velocity is increased the economy of fuel is decreased, from the failure of the absorbing and transmitting power of the boilers to convey more heat in less time to the water.

The comparative heat transmitted by conduction, radiation, and convection may be tested by alternately placing a thermometer in contact with the flame of a candle, next by its side, then over the top of the flame, and noting the temperature at each of the three positions. Or if the hand be cautiously substituted where a thermometer may not be convenient, the respective differences will be sensibly indicated, and give a clear idea of the heat lost by convection, when its velocity is considerable, and the absorbing space limited. In this respect Stephenson's and England's long boilers have an evident advantage over shorter boilers, where the diameters of the tubes do not offer sensible obstruction, for the largest portion of locomotive heating surface is on the worst or radiatory portions, at slow velocities, but decreasing as the increase of velocity extends the flames through the tubes. The experiments made by Mr. G. Stephenson, many years ago, showing the comparative evaporative ratio between the fire-box and tubes of an engine at rest, as 3 to 1, would scarcely apply to an engine at very high speeds, since the relative conducting or radiating surfaces are not uniform, but vary with the velocity of the engine and heating power of the fuel. With a low velocity these surfaces might be more uniform, if the flame acted only on the fire-box.

The comparative evaporation of water into steam depends therefore, first, upon perfect combustion; and, secondly, upon the absorbing and transmitting power of the boiler.

Where these powers are equal, the effects would be in the ratio of the surfaces of conducted and radiated heat, but where unequal in the ratio of their transmitting power only. Careful management of the fire to prevent "air-holes" burning through in places, a due regard to the air-admission spaces being uniform, and a steady regular supply of fuel, have considerable effects upon the economical results from any boiler. A clear level fire, kept fed by regular-sized pieces of fuel, and the fire-grate kept free from clinkers, all contribute to economy, and should be practised. To aid the fireman or driver in their duties, as well as for the higher objects of research, there should be in every locomotive boiler one glass pane in the fire-door, and one in the smoke-box door, that both the fire and the state of the escaping heat might be seen, without opening either door, until such was really necessary. The chilly effect of opening the fire-door in checking the production of steam is well known, and might be so far avoided whilst the experienced eye would soon detect whether combustion was or was not perfect, and act accordingly. There is no practical difficulty in doing so, for both in this country and in America it has been done by our best experimenters, and, of course, could be done in daily practice with good results. A good self-acting feeder of fuel is desirable.

Theories of Heat.—However well known may be the effects of heat, or the sensation it produces—whilst exhibiting its gentle docility in supplying the many wants of man, its destructive powers in conflagrations, explosion, or artillery; its potent sublimity in the thunder-storm; its awe-inspiring force in the heaving earthquake; its formidable grandeur when issuing from the volcanic safety-valves of the great globular boiler on which we live; and the immense magnitude of its former operation in forming the shell of that boiler, all proving its power and influence in creation—its real nature remains a matter of doubt, for its subtilty and extensive range of action have as yet defeated definite analysis. This may appear singular to those who have only regarded heat as a common-place agent, since it is found still determinable at 480° below Fah. zero, whilst the sun and electricity attest its concentrated energies. This intense heat and light are strikingly exemplified in the Great Exhibition, as already referred to. However, as correctly observed by a recent investigator of its phenomena (Herapath), "Every one knows the sensation of heat, though it may be difficult to describe it."

The following is a brief outline of the prevailing theories of its nature, followed by a few practical remarks on them.

There are two theories of heat which more particularly engage attention, with a third, derived from the others. The prevailing one is, that heat is a fluid of so subtle a nature as to preclude any direct investigation of its nature, which fluid is called caloric. The next theory is, that heat is not a material fluid, but is the effect of motion, and its intensity regulated by the momentum of the atoms in motion. The third theory is, that heat is the motion of an elastic fluid universally diffused.

Calorific Theory of Heat.—This theory assumes that heat is a material fluid called caloric, which is communicated from one body to another by conduction, radiation, and convection.

This theory is also accompanied by the doctrine of latent heat, to account for the heat contained in any body not measurable by the thermometer, and therefore difficult to analyze as a property of a material body.

Considering the prominence which the doctrine of latent heat has long borne in reference to steam, it will be necessary to fully explain it.

Latent Heat.—Latent or hidden heat is that heat which is not measurable by a thermometer. For example, the temperature of ice is 32°, but it requires 140° of heat to convert that ice into water again, which is called the latent heat of water, because the 140° are not indicated by the thermometer.

At 212° water begins to pass off into steam, but it requires the same amount of heat to be continued nearly six times as long as raised the water to 212° to convert it all into steam, which is thus called its latent heat. Taking the temperature of water as 52° we have $212^\circ - 52^\circ = 160^\circ$ of heat added to the water to raise it to the boiling point, and $160 \times 6 = 960^\circ$ usually reckoned as 1000° for the latent heat of steam under the pressure of the atmosphere, but strictly 965·7°.

Regnault found, from an able series of experiments, from 1 up to 13·6 atmospheres, the total heat of steam increase from 1170° up to 1230° Fahr., while the diffused heat decreased from 973° to 878°. The Franklin Institute found the diffused or latent heat of steam of 212° to 215° temperature from 995·3 to 1038·5°.

Motion Theory of Heat.—This theory is, that heat is an effect measured by the motion of particles having power to communicate that motion to other particles or to other bodies. If the motion be greater in one part than in another part of the same body, the heat will be unequal, but with a tendency to equalize the temperature throughout the mass. The power to heat would be as the temperature directly and the number of particles in motion conjointly. By bringing a thermometer in contact with a body, the motion would be communicated to the mercury, and the amount of motion be read off in the scale of parts as usual. Atoms or particles of bodies moving towards each other would unite, forming a smaller number of particles with more heat for each, but if the motion tended to separate the atoms, the temperature would decrease with the decreased momentum.

When water becomes ice, the particles combine, and the motion or temperature remains uniform, or when water becomes steam, the atoms are divided with a less temperature for each, but an increased aggregate temperature.

There is, therefore, a growing disposition to regard heat as an effect similar to light, heat, space, or electricity, and that this effect arises from motion.

Theory of Heat as a Fluid in Motion.—This is merely a combination of the leading features of the calorific and motion theories, evidently based on the idea so natural to all finite minds, that by some finite agent the effect of heat might be accomplished. This theory regards heat as a fluid in vibratory motion capable of producing all the known results or phenomena attending the evolution of heat.

It differs from the motion theory by regarding the fluid as material, but agrees with it in all other points as to the effect of motion in developing heat. The remarks, therefore, on the motion theory will apply to this one, excepting the materiality of the agent, which is the difficulty required to be solved—whether heat is or is not a material body.

Remarks on Theories of Heat.—To an ordinary observer there is a difficulty in reconciling the doctrine of latent heat with the simple laws of nature, yet it is no ordinary matter to differ from the many able men who have supported this doctrine. A conviction, however, that as regards steam it is untenable, leads to the following remarks, being submitted with every deference to those who take an opposite view:

The usual definition of "latent" is *hidden*, and that the heat in any body which is not measurable by a thermometer is latent heat. Now it may be observed that the heat-producing properties of bodies differ greatly, and are quite distinct from their sensible heat. Thus stones from the quarry and coals from the mine, have little difference of thermometric heat, but on combination with oxygen their power of generating heat is very different. If this property of bodies evolving either heat or other body peculiar to their atomic formation be considered as a latent or hidden power, it should follow by parity of reasoning that the effects of sound, or light produced by a change of circumstances from any other body, would be the latent power of such body. For example, a piece of artillery fired along a narrow street, produces a sound accompanied by a motion of the air sufficient to break the glass in *closed* windows, but not in open ones, which leave a passage for that motion to exert its force on the more resisting walls. Minute calculations are given to inform us that the harmonious sounds of musical instruments are the effects of definite numbers of vibrations in a second of time, that the range of these vibrations for vocal music are for a male voice from 384 to 1266, and for a female voice from 1152 to 3240; that the highest note in music (five octaves above the middle C of the piano) is due to 8192 vibrations in a second, the next C 4096, the third C 2048, and so on to 16 vibrations, as the lowest note in music. The sharpness of the sound being due to the number of times the vibrations strike the air in a second.

Now, if sound be the effect of motion, and the variation of sounds results from the number, momentum, or delicacy of these motions, heat may be equally the effect of motion, and its quantity due to the same changes of that motion as sound. For the animating tones produced by the accomplished performer from a pianoforte, organ, or violin are equally hidden or latent, before being evoked by the impressive touch of the skilful artist, as is the heating power of fuel before ignition calls it forth.

It seems, therefore, more in accordance with the simple laws of nature, to regard heat and sound as both phenomena called forth by motion, and amenable to the same general law. The power required to produce the motion of sound, is fairly represented by the force of heat required to give a higher degree of motion or temperature, so that the power of touch, or of mechanical agency in musical instruments, has its equivalent in the quantity of heat requisite to produce certain changes of temperature in given bodies, and will be measured by the resistance to greater motion of the particular body.

It is usually advanced as a proof of the latent heat of steam that no additional heat imparted to the water increases its temperature beyond that due to the pressure on its surface, whilst six times the heat added to boil it is required to make that water into steam of the same temperature as itself. This, however, can easily be shown to be a good example of the law of equal diffusion by a very simple experiment.

Let a glass vial represent a boiler partly filled with water, and placed over the flame of a candle. At first there is no visible circulation in the water, but it soon begins, and continues to increase until small globules are observed to form at the bottom from some of the descending atoms of water, and as soon as formed dart off in an irregular zigzag ascent to the surface, retaining their spherical form. The circulation increases until ebullition commences, and larger and more numerous globules are formed, crossing each other's paths in their ascent to the top, where they expand into steam nearly 1700 times more voluminous than the water inclosing the globule.

The questions then are, what are these globules? and, why are they in such haste to escape from the water? The reply which naturally occurs is, that these globules are ascending atoms of heat instantly caught up and surrounded by their equivalents of water, forming steam of a specific gravity about 1300 times lighter than the water, and about 1·6 times lighter than the air pressing on the water; hence their hurried irregular ascent is due to their less specific gravity struggling against the friction of the resisting water to their escape from confinement. These zigzag ascents of the little globules of steam bear some resemblance to the path of the forked lightning darting through the atmosphere, and since the friction of condensing steam issuing through small orifices is abundantly proved by Armstrong's hydro-electric boiler to produce vast quantities of electricity, is it impossible that the friction of these small globules through the water may not also evolve electricity? Armstrong's electric boiler artificially divides the condensing steam to produce friction; boiling naturally divides the water into its equivalent atoms, of separate ascent, producing a vast amount of frictional resistance to the escape of the atom of heat and its surrounding film of water. Instead, therefore, of the heat remaining in the water, it is evident that as soon as the water reaches the temperature of combination for steam, the atoms of heat which penetrate the boiler are separately surrounded and carried out of the water altogether, to be diffused amongst the steam, but are neither lost nor hidden. For if it only requires six atoms of heat to maintain an equal temperature in 1700 spaces of steam, as one atom of heat did over one space of water, we have $\frac{1700}{6} = 283$ as the relative diffusion and activity of the heat in its new field.

Since condensation recalls both the heat and water to their original spaces again, it proves their diffusion, for it could not be expected that the quantity of heat which would raise the temperature of one room 10°, would equally raise the temperature of 1700 equal-sized rooms; yet such appears to be the inference drawn by those who denominate the diffused heat of steam latent or hidden heat, and its concentration as sensible heat. It will be seen, therefore, that it was a badly selected expression to call diffused heat latent or hidden, a description which is not applicable to the heat of steam. We do not usually call the heat of the air latent, yet it is in the ratio of the density of the air, as is familiar to all who have had experience with air-pumps. For increasing density raises the heat, as when phosphorus is ignited by the increased heat of the air compressed in a small syringe. On expanding cooled air it rapidly absorbs heat from surrounding objects until an equilibrium of temperature is restored. Professor Smith, the Astronomer Royal of Scotland, has fully discussed these properties in an able paper on the cooling of air in Indian houses, and refers to the following tables of the heat of diffused and compressed air by Mr. Petrie, as entitled to confidence. Besides showing the effects of diffused and concentrated heat in a given volume of the atmosphere, they will be useful for reference.

TABLE No. II.—*Decrease of the Measurable Heat in Air by Diffusion.*

A given quantity of air expanded to vols.	Decrease of temperature from 60° Fah.	A given quantity of air expanded to vols.	Decrease in temperature from 60° Fah.
0·000	508·0	2·	104·8
1000	457·2	1·9	97·9
500	441·	1·8	90·4
200	421·	1·7	82·3
100	398·	1·6	73·7
50	370·	1·5	64·2
20	320·8	1·4	53·9
10	272·9	1·3	42·5
5	210·9	1·2	30·
3	155·2	1·1	15·9
2·5	133·7	1·0	0·0

Table No. II. shows 508° − 60° = 448° below zero as the extreme ascertained cold, and 457·2 − 60 = 397·2 below zero as the temperature of air expanded without receiving any additional heat to 1000 times its original volume. Table No. III. shows 4572° + 60 = 4632° as the heat of air compressed to $\frac{1}{1000}$th part of its original volume.

TABLE No. III.—*Increase of the Measurable Heat in Air by Concentration.*

A given volume of air compressed to vols.	Increase of temperature above 60° Fah.	A given volume of air compressed to vols.	Increase of temperature above 60° Fah.
0·9	17·1	0·1	586·4
0·8	39·1	0·05	870·9
0·7	64·2	0·02	1363·5
0·6	94·3	0·01	1850·1
0·5	132·	0·005	2462·8
0·4	181·5	0·002	3524·0
0·3	251·	0·001	4572·0
0·2	360·7	0·000	

To apply these tables to any other initial temperature than 60°, add $\frac{1}{14}$, to the tabular number for higher, and subtract the same for every degree of lower initial temperature.

There has been and still continues to be considerable discrepancies between the quantities given of diffused heat by various investigators. Even the latest and most elaborate experiments of Regnault and the Franklin Institute differ in their exponents of that quantity. The following are a few of these discrepancies:

TABLE No. IV.—*Diffused Heat of Steam by different Authorities.*

	Fah.		Fah
Watt	950	Thompson	1016
Black	800	Clement	990
Southern	945	Painbow	958
Rumford	1021	Regnault	880 to 973
Ure	888	Franklin Institute	996 to 1035

The smallness of the quantities operated upon, and the delicacy of the operation itself render the slightest variation much magnified when applied to larger quantities. Their general approximation is, however, sufficiently near for all practical purposes, and for facility in calculation, 1000° is usually taken as the diffused heat of steam of atmospheric pressure, and 212° as the boiling point, or a total heat of 1212° Fah. Now, according to the doctrine that the latent heat diminishes as the sensible heat increases, steam at 400° temperature would only have 812° latent heat, whilst steam of the temperature of 1212° would have none; but instead of proving that the heat is latent, it proves only different stages of diffusion and concentration. Regnault's experiments show that whilst the total heat of steam is not uniform, but increasing, the diffused heat becomes less and less in quantity as the spaces occupied by a given weight of steam decreases. For as the pressure is increased the extent of motion of a given quantity is decreased, from the diminished volume of steam, so that whether at high or low pressures the temperature of an atom of heat will be inversely as the space it occupies, but not hidden.

In cooling water to the unnatural liquid temperature of 5°, its sudden release from that unnatural state produces excessive motion, developing 27° of heat as its measure of restorative force, which, in obedience to the general laws of nature, is comparatively arrested at 32°. Now, agreeably to the laws of motion, the friction of a body at rest is much greater than that of the same body in motion, hence the comparative rest of water in ice requires a force of 140° of heat to give it the motion of fluidity; and the comparative rest of fluid water requires a force of 1000° of heat to give it the motion of steam. The heat, therefore, which moves the ice into water and the water into steam is the power externally applied to produce higher degrees of motion, and that motion will be the measure of the force so applied, just as the intensity of sound is measured by the musical scale from the number or force of the vibration of motion, as already referred to.

Generally as an effect of motion heat will be measured by the power of the particles in motion to propagate and communicate it to other particles. Unequal motion in any parts of a body would produce unequal temperature, tending however towards an equality of temperature. The power to heat a body would be as the temperature directly, and the number of atoms in motion conjointly, which would be communicated to a thermometer in contact with it, and be read off in the usual manner.

Atoms moving towards each other would unite to form a lesser number, with a greater amount of heat for each, or, if the motion tended to separate the atoms, they would be more numerous, but with less temperature for each separate atom. Thus we see the atoms combine, and uniform motion of 32° is obtained. When water becomes steam, the atoms are separated with a less temperature for each, but an increasing aggregate temperature. For equal weights the heat of water would therefore exceed that of ice, and of steam that of water, as they are known to be by experiment.

It is further evident, that thermometers only measure the quantity of heat which is communicated to them, but not the space over which heat may be expanded, nor the aggregate heat contained in such space. In a large factory where a number of machines are put in motion by one engine, the aggregate power of that engine would not be indicated by the power required to move one machine, but by that power multiplied by the number of machines, and other resistances. Neither does a thermometer indicate the aggregate heat in any given space, as that depends upon both the capacity and temperature combined. It is therefore difficult to realize the idea that diffused heat can be hidden heat, and some better term of expression than latent heat should be employed, if "diffused" be not all that is necessary.

The application of the term latent to the undeveloped properties of bodies is, we think, equally untenable as it is to steam, and more appropriate terms should be employed, if they are not sufficiently conveyed to the mind by their customary names of air, gas, coals, water, ice, or stones. Indeed, it is satisfactory to observe the growing tendency to simplify scientific nomenclature, and the readiness with which it then passes into ordinary use, where the scientific name is most simple and expressive.

Dalton found that 1 lb. of hydrogen and 8 lbs. of oxygen burnt in a close vessel produced 9 lbs. of water, and gave out as much heat as melted 320 lbs. of ice, or 35½ lbs. of ice for each pound of the gases; but 1 lb. of steam only melted 8·35 lbs. of ice, or less than one-fourth the quantity melted by the equivalent weight of the gases. Now the thermometer does not indicate this vast difference, neither can it be the heat in the gas, since in the presence of intense cold it remains very little diminished in volume, whilst steam with very limited cold is condensed to water again. The heating power of gases is therefore like that of coals or coke, a property duly evolved under favorable combination. The light which these bodies give out may equally be designated latent, and darkness be only latent light. The sound they emit in giving forth heat and light may be equally latent. The chemical affinity, in short, all the peculiar properties of bodies, would thus be latent, until we should cease to call them by their customary names, and only see before our eyes a mass of latents. For example, Mr. Staite has shown that heat, light, electricity, magnetism, motion, and chemical affinity are all produced in one line in the voltaic pole, where the battery represents motion and affinity; electricity in the deflection of the needle; electro-magnetism in the helix; and heat and light in the ignition of the wire in irridium lamps placed in different parts of the circuit.

There is now a growing tendency to consider heat, light, electricity, and sound as phenomena of nature, intimately associated with each other, and amenable to the same general laws.

To draw general attention to the important nature of the composition of steam, these remarks on the theories of heat have been made, and those who desire to extend their information on these points will find them ably and scientifically investigated in Herepath's Treatise on Mathematical Physics, where the motive theory of heat is elaborately supported.

[For Appletons' Mechanics' Magazine.]

Fire-Grates of Marine Boilers.

ALLOW me to correct, through your journal, a mistake into which the editor of the *Mechanic*, a weekly paper published in this city, has lately fallen. To do so with effect, I would beg leave to copy the whole article from "The Mechanic" of Nov. 27.

"NEW MECHANICAL RULES, OR OLD ONES REVIVED.—We transferred to our journal a short time since, from *Appletons' Magazine*, a rule to determine the area of steamboat chimneys, the absurdity of which was then partially exposed; we are now obliged, in some measure, to transfer another, which is more ridiculous than the former, to determine the area of the grate for steamboat boilers.

"It is useless in the extreme for us to make any extended remarks upon such rules; indeed, we should not have noticed them at all, had they not emanated from a mechanical journal which has been considered the first in the country, and one which should command a large foreign exchange; it is on this ground that we have conceived it to be our duty to present them in their proper light, in order that the editor may become individually responsible for such ridiculous rules.

"If they were derived from foreign journals which have long since been obsolete, it was the duty of the editor to inform his readers of the fact, and thereby save American mechanics from the disgrace and obloquy which they have in times past received through American hot-house mechanical writers, who are only able to copy indifferently a foreign mechanical formula. But let us turn to the consideration of the *rules*. The reader is not permitted to understand the manner or the progressive steps by which they were derived; the 'vulgar mechanic' is not able to understand or appreciate the 'higher laws in the mathematics'* by which they have been deduced. But what are these higher laws? Why, it consists in finding the area of a circle, tracing the result of mechanical actions, &c., by algebra; it consists in resolving a few elements into an equation, by which their various relations can at once be discovered; an operation which could be accomplished much more easily arithmetically; but to perform the calculations by vulgar arithmetic cannot be countenanced for a moment! the reason is, that these operations would even become ridiculous to themselves. The *rules* are expressed as follows:

"First rule: 'Multiply ·6 into the cube root of the length of stroke in feet, and this by the square of the diameter of the cylinder in inches, and divide this product by 47; the quotient will be the area of the grate in square feet.'

"The *second rule* to obtain the *same* result is expressed as follows:

"Second rule: 'Multiply the nominal horse-power by ·6 for the square feet of grate.'

"Without any further remarks, we will select the editor's example, and obtain the area of the grate by both rules. His example is given in algebra, but we will work it out in arithmetic.

"'Example: What is the fire-grate for an engine of 95 inches diameter of cylinder, and 9 feet stroke?' The operation in arithmetic, by the rule, becomes:

Square of	95 = 9250
Cube root of..................	9 = 2·08
	11544
Constant number	·6
Constant number	47)11544(
	245 feet,

area of grate by first rule.

"We will now obtain the same result by his second rule. We ought to observe that the editor of the *Magazine* does not obtain the area of the grate by the second rule; if he had, perhaps one of them would have been omitted.

"The nominal power of this size engine becomes:

Area of 95-inch cylinder	= 7088 inches.
Pressure of steam.................	24 lbs.
	170112
Velocity of piston.................	350 feet.
One horse-power........... 33000)	59539200(
	1804 h. p.
Constant number	·6
	1082 feet,

area of grate by second rule; or,

Area by first rule	= 245 feet,
Do. second rule...................	= 1082 "

or as 4 to 1, nearly.

"Here we have two rules, one of which gives four times as much area as the other. We should observe that the nominal pressure of the steam is quite low, and the velocity of the piston is below the usual rate; which, when corrected, the difference will be still greater than we have deduced.

"It may not, perhaps, be without utility for us to strip these rules of their gaudy dress, and present the relations of each element in its proper light. In order to accomplish this, we shall be obliged to introduce the two equations thus:

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* The phrase "vulgar mechanic," &c., were not used in this Magazine. The quotation marks seem designed to convey a false impression.—[*Ed. A. M. M.*]

$$\text{A} = \frac{\cdot 6 \times d^2 \times \sqrt[3]{s}}{47};$$

$$\text{A} = \frac{d^2 \times v \times p}{33000} \times \cdot 6.$$

$$\text{Or, } \frac{\cdot 6 \times d^2 \times \sqrt{s}}{47} = \frac{d^2 \times v \times p}{33000} \times \cdot 6;$$

$$\text{Or, } \frac{\sqrt[3]{s}}{47} = \frac{1}{33000}.$$

"Which shows that the square root of the length of the stroke is the amount of the error in the two rules. Our readers must excuse us for occupying so much space in the correction of such palpable errors."

By reference to the November number of the Magazine, p. 249, it will be seen that but *one* rule is given for the area of fire-grates, and this rule embodies simply the factors for obtaining the nominal horse-power of an engine, according to Watt's rule, explained in the July number of the Magazine, p. 150, with the addition of the factor ·6. The editor of a mechanical paper professing to *teach*, should know *that the cube root of the length of stroke in feet, and this multiplied by the square of the diameter of the cylinder in inches, and divided by* 47, is the rule received by the best authorities for the *nominal* horse-power of a condensing marine engine; and if ·6 of a square foot per nominal horse-power be a proper proportion for the grate, as experience fully confirms it to be, it is the same *identical* rule, whether we multiply the nominal horse-power by ·6, or multiply the factors expressive of the nominal horse-power by the same number.

The editor of "The Mechanic" has, in a short article, shown his peculiar fitness for the editing a professed mechanical paper; and the modesty apparent in this attempt to place his seniors in a false position, is too refreshing to pass unnoticed. In the first place, his ignorance—as admitted by himself—of the source from whence this rule was derived, should have led him to refrain from meddling with what he was incapable of understanding. In the second place, his failing to recognize the generally received formula for the *nominal* horse-power of an engine, shows a wonderful acquaintance with a subject upon which he presumes to criticise others. Thirdly, not understanding that what he calls the *second* rule was but the *first* given in simpler language, shows an acuteness of discrimination rarely observable in scientific criticism. Fourthly, calling the exhibition of arithmetical factors *algebra*, because the *symbols* of the operations to be performed were used instead of performing the operation, shows a wonderful appreciation of the powers of arithmetic. Fifthly, his introduction of 24 lbs. in his calculation as the "nominal pressure of the steam," and 350 feet as the "velocity of the piston," both being noted as "*below*" the usual rate, all show a most intimate acquaintance with the labors of eminent men in this field of mechanical science; but the climax appears when he proceeds to "strip these rules of their gaudy dress, and present the relations of each element in its proper light."

If any of the readers of the Magazine can perceive in this paragraph that "the amount of the error in the *two* rules is the *square root of the length of the stroke*," we would recommend, by all means, that they subscribe to "The Mechanic." The editor felicitates himself upon the "correction of such palpable errors!" W.

The New English Patent Law.

The "Patent Law Amendment Act," 1852, has now got fairly to work, and, by the time this page issues from the press, remarks the *Glasgow Practical Mechanic* for November, there is every probability that the number of separate applications for patents under it will amount to 500. The very important changes as to cost, and the routine of patenting introduced under this law, must render all practical information thereon of some value in the estimation as well of inventors as of that mass of the public which is interested in the progress of industry:

Inventors, whether British subjects or Foreigners, may obtain Letters-Patent from the Crown, protecting, for fourteen years, such Inventions as they themselves have made, or have derived from foreigners not domiciled here. But the Patentee must himself be the actual Inventor, or the first importer of an Invention; and a Patent for any part of the realm will be void, if the Invention, in respect of which it was granted, was publicly known in another part of the realm at the date of the Patent. And where the subject has already been patented in any foreign country, the British Patent will cease at the same period as the Foreign Patent. No Patent can be obtained for an Invention for which a Foreign Patent has been granted, and has expired.

One Patent will not be granted for several distinct and separate inventions, but the Patent will not be refused where one Invention is applicable to the improvement of several manufactures, or where several Inventions are applicable to the improvement of one and the same manufacture.

The Title.—When an Inventor has resolved to apply for Letters-Patent, the first thing to be considered is the Title of his Invention, which must be given in the Patent. There is often a good deal of difficulty in selecting a proper Title, and Inventors have not unfrequently lost the benefit of their Patents in consequence of an error in this point. In cases of doubt or difficulty, the Inventor ought to apply at once to a Patent Agent.

When the Inventions are applicable to known manufactures, or to known machines, the Titles of Patents must state the manufactures or the machines; and, where it can conveniently be done, the part thereof to which the Inventions relate.

When a manufacture is carried on by several distinct processes, branches, or machines, the Title of the Patent must state to which of the processes, branches, or machines, the Invention relates.

If the Invention relates to an engine for producing power to be worked by mechanical means, or by water, steam, air, or gases, galvanic or other fluid, the Title must state which of the means is to be used.

If the Invention relates to some process to be performed on known fabrics or manufactures, the process and manufacture must be stated in the Title.

If the Invention relates to the application of known materials to new purposes, or to the improvement of old manufactures, the Title must state the purpose or manufacture, and may state that it is to be improved by a new application of known materials. It is, however, the most prudent course for the Inventor to supply his Agent, in the first place, with the fullest possible description of the Invention, and leave him to draw the Title in accordance with it.

Provisional Protection.—Inventions may be protected so as to enable their owners to use and sell them for a period of Six Months, on lodging, with a Petition and Declaration, a Provisional Specification, and having obtained the Law Officer's certificate, approving of the Title and Provisional Specification.

The Provisional Specification must state the nature of the Invention, so as to distinguish it from what is already known, in order that the extent of the Invention may be clearly understood. It need not, however, describe the manner in which the Invention is to be performed.

The object of a Provisional Specification is to provide against the introduction into the Complete Specification of any matters of Invention differing from those for which the Letters-Patent are granted. It is not intended in any way to prevent the Patentee including in his Complete Specification those improvements in practical details which may occur in carrying out his Invention, provided that those improvements require the use of the original matter of Invention which is set forth in the Provisional Specification for which the Patent is granted. As the validity of the Patent depends principally upon the Provisional Specification, it should be framed with the greatest care and consideration. The entire expense of this step, including all agency and other charges, is £10 10*s*.

The Petitioner may file a complete Specification, if he thinks proper, with his Petition and Declaration, in which case the Invention is protected from the day of the deposit, but it does not appear advisable to adopt this course in many cases.

Completion of the Patent.—The Patent must be completed prior to the expiry of the six months' Provisional Protection, and as twenty-one days' notice by advertisement is to be given in every case where a Petitioner is desirous to proceed—and, if opposed, a further delay of more than a week will take place—the Inventor must determine on proceeding or otherwise at least six weeks before the expiry of his Provisional Protection.

The entire expense of a Patent for England and Wales, Scotland, and Ireland, is £30. When an intending Patentee calculates the cost of his undertaking, he must add to this the cost incurred by a Specification.

The Specification.—Within six months from the date of the deposit of the petition, declaration, and particulars of the Invention, a Specification has to be prepared and filed. This instrument requires the utmost care in its preparation, and, if necessary, it must be accompanied by drawings. The insufficiency of Specifications has led to the loss of more Patents than any other cause. The cost of a Specification varies, of course, with the nature of the description, the plans, drawings, &c.

Where drawings are required to explain the Invention, five copies have to be prepared—one to attach to the Deed, another for the office where filed, a third to be deposited in an office in Edinburgh, the fourth for a similar office in Dublin, and the last for the Queen's Printer, by whom all Specifications and accompanying Drawings have to be printed.

To enable Inventors desirous of protecting their Inventions from being pirated until they have themselves obtained Patents, and to afford manufacturers and others information as to applicants for Patents for any particular manufacture, notices will be forwarded to parties desiring them of all applications for Patents for any one subject, for one year, on payment of one guinea. This system is adopted to replace the old plan of caveats, the Law Officers having, under the recent Act, abandoned the issue of caveat notices.

Inventors residing in the country should forward the particulars of their Inventions to their agents, who, by return of post, will forward the necessary papers for their signature, and will obtain the Provisional Protection within a week from the day of application.

Such a total change as this may well be looked upon as affording a new impulse to invention, and a vast extension of the field of commercial enterprise.

LIST OF PATENTS,

Issued from the U. S. Patent Office during the month of November, 1852.

E. P. Bigelow, of Clinton, Mass., for improvements in Pile Wires and Pincers, for weaving Pile Fabrics.

Claim.—I do not wish to confine myself to the precise form of the parts represented; nor do I claim constructing them for hand-looms; but I claim making one part of the pile-wires, which is to be grasped by the pincers, wedge-formed or oval-shaped, in combination with grooves in the jaws of the pincers, to conform thereto, substantially as specified.

Nicholas Bucker, of Weedsport, N. Y., for Edge-Planes for Shoemakers.

Claim.—Securing the plane-iron or knife in a sliding tang, passing through a mortise in the body or handle of the plane, substantially as set forth, whereby, with great simplicity of construction, I obtain the facility of adjusting the instrument to the thickness of the sole of the boot or shoe, and of employing the draw-cut.

Christopher Hodgkins, of Boston, Mass., for Improvements in Sewing Machines.

Claim.—I do not claim, in the mechanism for feeding the cloth, a notched bar, which has a vertical or up-and-down motion, for fastening the cloth upon and relieving it from the notches of said bar, by striking it against a yielding plate, and a lateral motion, or motion forward and back; but I claim the employment of one or more burr-wheels, applied to the carriage, and kept continually against the cloth by a spring (so as to preserve the cloth from falling away from the spring-plate or presser over it), in combination with a spring-brake, operated as described, the whole being combined and made to operate together, as specified.

And in combination with the presser and the lower needle, I claim a mechanism by which an increase of thickness of the cloth is made, the lower needle to the left, the distance required to bring it into correct position with respect to the upper needle, so as to prevent the said upper needle from passing into the cloth before passing into the bow of the thread of the lower needle, as set forth.

And I claim the combination of the slide-rod, the box, screw, slotted arm, shaft, arm I, connecting-rod, slide, stationary plate, and cam-plate, as applied to the fulcrum-pin of the lever, and to the pressure for the purpose of moving the lever, with respect or nearer to the cam, for the purpose described.

Franklin Kelsey, of Middletown, Ct., for improvement in Vibrating Propellers.

Claim.—The combination in a field or row of a multiplicity of inclined planes, or sculls secured by gudgeons, on one of the sides thereof in a frame vibrating horizontally, and the graduation of their propelling velocities by a similar multiplicity of check-pins or stops, so adapted to the respective planes or sculls that in vibrating the same they may propel as nearly as possible in equal times, and thereby reduce the propelling principle of the tail of a fish, as nearly as may be, to mechanical purposes, as described, for the propelling of all kinds or classes of vessels or boats by the power of steam, or other power, and with or without sails, as occasion may require.

John Laidlaw, of New York City, for Improvements in Gas Metres.

Claim.—The chamber and siphon, in combination, in the manner substantially as described, with the pipes, or other pipe or pipes, having an opening, or openings, at the required level of the liquid in the metre, for the purpose of preserving the level and discharging the surplus liquid from the metre.

J. D. Olstot, of Springfield, Ohio, for improvement in Saw Gummers.

Claim.—The combination of the frame, shoe, and set screws, in the manner and for the purpose set forth.

Wm. T. Richards, of New Haven, Conn., for improvement in Wire Ferrules.

Claim.—I am aware that wire ferrules have been made, when the coil has been cut directly across the wire, I therefore do not claim the manufacture of wire ferrules, as such, but I claim the manufacture of ferrules from iron wire, by cutting them from a helical coil, in such a manner that both ends of each ferrule will be perfectly smooth, true, and square across at right angles to the length, so that no other finishing of the ends will be needed to render them fit for use, and so that when soldered they will be the most convenient and durable ferrules which can be made, when manufactured in the manner described.

Charles Randall, of Palmyra, Ga., for Improvement in Seed Planters.

Claim.—The two hollow disks, combining a hopper, plough, and carrying wheel, substantially as described, in combination with the segment plates, or their equivalents, by which the discharge of seed is regulated, operating substantially as set forth.

M. C. Saddler, of Brockport, N. Y., for Improvement in Cooking Stoves.

Claim.—The guard-plate for carrying the products of combustion under the oven, that part thereof may pass around and over it to the front, and the rest continue to and up the back flue, substantially as specified, in combination with the recess in the rear of the fire-chamber, for extending a portion of the fire near to the oven, and the deflection plate for dividing the draught and carrying it towards each end of the oven, as specified.

Francis Townsend, of Cambria, N. Y., for improvement in Seed Planters.

Claim.—In combination with the regular and positive discharge of seed by means of the ordinary seed distributor, of seed drills, I claim the supplemental or occasional discharge of seed, by a supplemental seed distributor, put in and out of action at the discretion of the operator of the machine, substantially as set forth.

C. S. Trevitt, of Ellicottsville, N. Y., for improvement in Seed Planters.

Claim.—The combination of the perforated register plate, the adjusting screw, and the springs, arranged and operating as described.

Henry Vernoillion, of Rising Sun, Md., for improvement in Seed Planters.

Claim.—I do not claim the use of a reciprocating gage-plate, having oblique feed openings therein, operating in combination with openings of different obliquity, in the grating plates and bottom of the hopper, for increasing or diminishing the feed of the seed to be sown, while the machine is in motion, by increasing or diminishing the traverse or sliding movement of the gage-plate.

But I claim the employment of the pivoted oscillating plate, when made with oblique openings, on opposite sides of its centre, reaching to and forming outlets at the circumference of said plate, in combination with segmental or other similar openings above the oblique openings, and a central annular opening in the ring-plate, whereby, during the oscillation of the pivoted plate, the seed is not only discharged from the outlets of the oblique openings over the circumference of the ring-plate, but also through the central annular opening of the ring-plate, from the centreward ends of the oblique openings.

David Wells, of Lowell, Mass., for improvement in Ventilators.

Claim.—I do not claim a ventilator made of a series of flat plates, arranged in a circle with openings between them, nor do I claim one made of a series of plates arranged in a circle or around an axis, and with openings between them, and each made to stand tangential or curved (transversely) to the arc of a circle or curved line of the set of plates; but I claim a ventilator constructed of a single series of curved or angular plates, and openings, and capped, connected with a tube or flue, and having each plate curved or made angular convexly or concavely, out of the general line of their arrangement around a common axis.

F. C. Goffin, of New York City, for improvement in method of securing Vault and Safe Doors.

Claim.—Securing or fastening the doors of safes, bank-vaults, &c., by means of movable flanches arranged and attached as described, by which means a continuous bolt is formed all around between the door and its mouthpiece, preventing the admission of air into the safe, which is thereby rendered secure against fire, and the door against force.

James Greenhalgh, of Waterford, Mass., for improvement in Counterbalancing Harness in Looms.

Claim.—I do not claim the mere upright position of the jacks, or the mere counterbalancing of the harness; but I claim the construction of the long double-heddles or jacks, in such a manner, and so hanging them on the axle by a short arm, or its equivalent, that, in their vibrations, neither end of them shall pass beyond a vertical plane passing through the axle on which they rock or oscillate, so that the weight of the jacks shall be thrown outside of their points of suspension, thus counterbalancing the weight of the harness.

Wanton Roose, of Taunton, Mass., for Self-Acting Mules.

Claim.—I claim (without confining myself to the precise construction and arrangement of the parts, or to the precise manner of operating them), first, backing off or reversing the spindles, to unwind the yarn from them, and regulating or altering the amount of backing off, as the building of the cops progresses, by means of a step or incline of varying form, extending along a revolving cam, or its equivalent, substantially such as is exemplified on the cam, the said step or incline governing the revolution of the spindles.

Second, the mechanism for making the finger, through which the irregular surface of the cam, or its equivalent, acts upon the mechanism which drives the spindles in backing off and building on, traverse the said cam, or equivalent, and keep it to the surface, consisting of the screws, the nut, cord, or chain, lever, and stud, operating in combination, as described.

L. P. Jenks, of Boston, Mass. (assignor to J. W. Page, of West Roxbury, Mass., assignor to G. A. Gardner, of Boston, Mass.), for Machines for Drilling Stone.

Claim.—The arrangement in a swinging or other frame for the purpose of drilling rods of two cross-heads, the one with a reciprocating motion, and the other connected therewith and bearing the drill with a reciprocating and progressively advancing motion, substantially as described, and this, however such alternate advance and recession may be effected.

Also, the arrangement of a sliding bar for the purpose of changing both the rate of rotation and the rate of advance of the drill, by one movement, for the purpose described.

I do not claim the ratchet-wheel and pawl-holder operated by the inclined groove by itself; but I claim the making the ratchet cylinder, or equivalent rotating arrangement, sliding upon the mandril or drill-stock as the same advances, in such manner as that the pawl-holder projection retains its place in the inclined groove as described.

J. G. Bradeen, of Boston, Mass. (assignor to himself and George Perkins, of Malden, Mass.), for improvement in Sewing Machines.

Claim.—Two rotating draft-hooks or their equivalent, separate from the needles in combination with the two needles, and two thread-guides made to be operated together, as specified.

And I claim the improvement of so constructing and operating the needles and thread-guides, that each needle, directly after passing into and through the cloth, shall pass through the thread-guide, which is on that side of the cloth, opposite to the side of it, in which the needle first enters, meaning to claim the arrangement of each needle and its thread-guide, respectively on opposite sides of the cloth, they being constructed and operated as specified.

I also claim the combination of the rocking thread-lifter, or its equivalent, with the needle and presser, the said thread-lifter being operated, as described, by the thread-guide lever, or any other proper means.

William Bullock, of Philadelphia, Pa., for Hand Seed Planters.

Claim.—First, a seed planter, having a tube or tubes, which, in operating the planter, are closed when placed in the ground, and so arranged that it or they can be opened while in the ground, for the purpose of letting the seeds out.

Second, the arrangement of two or more tubes in such a manner that the operator can place the seed in a hill at specified distances apart.

Third, the feeders, having a sloping cavity at the outer ends, and so arranged that, as the seeds are carried up, they will slide out and pass into the tubes.

Fourth, the arrangement of the feeders and jaws, or valves of the tubes in connection with the handle, by which the machine is carried, so that the feeders and jaws, or valves, can be operated by the same hand with which the machine is carried.

Wm. P. Chadwick, of Edgarton, Mass., for improvement in Oil Presses.

Claim.—The arrangement of the screw within the body or interior of the box, in combination with and so applying it to one head of the box, and to the platen, that, by its revolution in one direction, the platen will be drawn towards the said end of the box, all substantially as specified, not meaning to claim the combination of a screw, platen, and box, but intending to limit my claim as described.

Joel Densmore, of Blooming Valley, Pa., for improvements in Printing Presses.

Claim.—The combination of the fingers or grippers for seizing the sheets and holding them to the cylinder, and the fingers for throwing the sheets off from the cylinder, said fingers or grippers being attached to shafts arranged longitudinally to the cylinder, and attached thereto, and being turned to give the necessary movements to the fingers, by the revolution or vibration of the cylinder, through the agency of cranks and rods, or their equivalents.

Thomas H. Dodge, of Nashua, N. H., for improvement in Marine Signals.

Claim.—Placing the lamp on a movable pedestal or its equivalent, inside the many-sided signal box, and raising and lowering the same from one colored glass to another, by means of the cord and pulley, or their equivalents, the whole being constructed, arranged, and operating in connection with a signal, in the manner and for the purposes, substantially as described.

Abijah Hulburt, of Augusta, Ga., for improvement in Turning Jaw Vises.

Claim.—I am aware that the revolving jaw of a vise has been set, and then secured to any desired angle with the fixed jaw, and I do not claim the so doing. But I claim constructing the jaw of a revolving vise, with a flange or projection provided on the edge thereof, with a left-handed screw, in which meshes a screw, or other equivalent, operating on said jaw, in the manner set forth, by which I am enabled both to set and secure the revolving jaw at the same time.

Thomas Mardock, of Cincinnati, Ohio, for improvement in Saddles.

Claim.—The construction of a saddle with seat attached to the pommel and cantle, by lips, as described, or in any equivalent manner, so as to be easily removable for the inspection, and, if need be, alteration of any part of the saddle.

Stephen C. Mendenhall, of Richmond, Ind., for improvement in mode of Throwing Shuttles in Looms.

Claim.—The combination and arrangement of the spring triggers, cords, and treadles, &c., so that the depression of any one of these treadles shall release the triggers on the forward movement of the lay, and allow the picker staff to actuate the shuttle substantially as set forth.

Stephen C. Mendenhall, of Richmond, Ind., and Obed King and Ezra King, of Salem, Iowa, for improvement in Hand Looms.

Claim.—The combination of a nerve, operated by lay, inclined plane, and its guides and adjustable pin, or their equivalents, combined and operating as described, so that we can operate and vary the number of heddles, substantially as set forth.

We are aware that the picker staff has been operated by hooks, alternately raised from the shoulders on the picker staff, by pins on a vibrating slide operated by groves in the treadle cam: this we do not claim. But we claim the combination of the inclined plane on picker staff spring and hooks, for the purpose of sliding the hooks, in the manner specified.

L. D. Phillips, of Michigan City, Ind., for improvements in Steering Submarine Vessels.

Claim.—The arrangement of the shaft of the propeller, so as to pass through and be guided by the tiller, or the equivalent thereof, mounted on a universal joint, in order that the propeller may be driven by one hand, while the vessel is steered in any direction by the other, substantially as set forth.

I also claim the combination of a universal rudder, with a series of keels arranged on the top, bottom, and sides, of the vessel, to aid in steadying her, and to facilitate the steering of her in various directions, by means of a universal rudder, substantially as set forth.

Solomon Shetter, of Alleghany, Pa., for improvements in Horse-Shoe Machinery.

Claim.—The arrangement of shifting dies and adjustable levers and cams, substantially as set forth.

Harvey Silver, of Lowell, Mass., for improvements in Twisting Tubes in the Formation of Roving.

Claim.—First, the construction and use, of tubes for giving countertwist to roving, by having a slot in the side, in such a manner that the roving can be laid into the tube, without the use of a hook, as described.

Second, the construction, arrangement, and use of tubes, for giving countertwist to roving, in such a manner that without disengaging the driving apparatus, the tube can be so turned on its support, that a hook can be passed between the bosses of the rolls through the revolving tube, to draw the roving into the tube, without stopping the parts, as described.

Third, the construction and use of tubes for giving countertwist to roving, by making them in two parts, into one of which the roving can be adjusted and then dropped into the other, giving it the necessary rotary motion to form the twist.

Giles Slocum and M. T. Sayles, of Lansingburg, N. Y., for improvements in Machinery for Crimping Metal Bars.

Claim.—We do not claim the flexible die, nor the combination of the permanent and flexible dies, as they have been previously used; but we claim the peculiar manner of operating said dies, as described, viz., by means of pressure rollers, being fixed permanently in the frame, and the upper rollers arranged so as to yield to the die, when necessary; the movable bed being attached by a cord or chain to a roller, by turning which the bed is drawn between the upper rollers and the lower rollers, the upper roller forcing or compressing the flexible die upon the permanent die, and bending or crimping the bar, as set forth.

George S. G. Spence, of Boston, Mass., for improvement in a Cooking Range.

Claim.—The combination of a heat radiating chamber, applied to the rear end, and two draft flues applied to each of the four faces at top, bottom, and two sides of an elevated oven of a cooking range; said combination of flues causing the smoke and other volatile products of combustion to pass from the back of the flue space under the boiling chamber into a flue leading under the rear part of the oven, and transversely across or from side to side of the oven, thence up a flue leading against such side of the oven, thence down a flue leading against such side of the oven, thence into a reservoir flue leading transversely across, and under and against the bottom of the oven, thence upwards into a flue leading horizontally and along the other side of the oven, and from front to rear of it; thence into and through a flue leading horizontally against such second or other side of the oven, thence into a flue leading across the top of the oven, and from side to side of it, thence into and through another flue leading over and against the said top, and in an opposite direction to the last-mentioned, and thence into the chimney or discharge flue.

Henry H. Strawbridge, of New Orleans, La. and Daniel Tyson, of Covington, La., for improvement in Brick Machines.

Claim.—We claim the roller, in combination with a reciprocating series of moulds, for the purpose of gaging the quantity of clay to be compressed into the said moulds, the several parts being arranged and operating as described.

We also claim the method of finishing the surface of dry clay bricks in moulds, by first shaving off the surplus material, and then smoothing the shaved surface, by rubbing it under heavy pressure, while confined in the moulds, to prevent it from breaking under the operation, as it would do if not so confined.

Seth E. Winslow, of Kensington, Pa., for improvements in Automatic Fans.

Claim.—The mode of operating the fan, by means of the rod impinging upon the floor, and made to react by means of a spring, substantially as set forth.

A. H. Wood, of Boston, Mass., for improvement in Gas Burners.

Claim.—The use, in a gas burner, of a distributor, constructed for the purpose of producing a steady jet or flame, and for preventing the blowing and waste of gas in the burner.

Moody Belknap, of Canton, Mass. (assignor to Moody Belknap and Lyman Kinsley, of same place), for improvement in Reciprocating Die Spike Machinery.

Claim.—I do not claim a series of two or more griping or holding dies made to rotate around one common axle or shaft; nor do I claim reciprocating dies, each provided with its own griping die; but I claim combining the two reciprocating bed dies (affixed to a carriage having a horizontal movement, as stated) with the griping lever, as the upper die for both, so as to operate therewith, substantially as described.

Charles S. Barnes, of New York, N. Y., for improvement in Expanding Bits.

Claim.—So forming and combining the movable and stationary parts of an expansion bit, for boring different sized holes, as that a cutting edge shall at all times be preserved entirely across the bit; and at the same time, the cutting point on the movable point thereof, shall always be parallel with the shank of the bit, or the line of the hole as described.

I also claim the rising and falling of the movable part of the bit, as it is contracted and expanded, by means of the inclined slots and set screws or their equivalents; so that the lip on the movable part, shall become the cutter, when boring the largest size of holes, (the other lip being at rest,) and the lip on the stationary part shall become the cutter, when boring small sized holes; the other lip being at rest, by which means I am able to form the lips of the proper shape for different sized holes, without changing the cutters, as described.

Levis H. Davis, Samuel and Morton Pennock, of Kennet Square, Pa., for improvement in Seed Planter.

Claim.—First, the employment of the sigmoid, or other similarly curved or angular receiving and discharging openings, in combination with the reciprocating slide and feeding stubs, for the purposes specified; the said reciprocating slide having angular points projecting into the said sigmoid openings, for effecting the discharge of the seed from the outlets from which the stubs are receding, while the latter are feeding the seed towards the opposite extremities or outlets of the openings, during each movement of the slide, by means of the inclined sides of said points, and the movement of the slide.

Lewis H. Chichester, of Brooklyn, N. Y., for improvement in Flax-Pullers.

Claim.—I do not wish to limit myself to the mere construction or arrangement of the parts. I claim the employment of one or more pairs of rollers, as described, in combination with the fingers or separators, or their equivalents, for presenting the stalks to the bite of the rollers, to be drawn in as described; also, in combination with the rollers—the revolving arm, or arms, for collecting and drawing the stalks to the bite of the rollers, and also the employment of the fulcrum bar, as described.

John A. Van Ripper, of New York, N. Y., for improvement in Carpet-Looms.

Claim.—First, actuating a positive let-off for the delivery of yarn, a positive take-up of the woven cloth, and a variable winding upon a beam of the cloth, delivered from the take-up rollers, by the combination of the crank-pin or cam on the disk, or the equivalent thereof, with the alternating bar and its appendages, as set forth.

Secondly, the method of working the trap-boards, by means of the crank-cam, rock-shaft, and arms, lifting-rods, cam, and lever, and the other devices acting in connection with those for raising, and lowering, and oscillating the lifting rods—the whole operating as described.

Thirdly, the temples, constructed, arranged, and operated as described; so that they will be open during the time the take-up rollers are acting, closed at the time the lay beats up.

Wm. Field, of Providence, R. I., for Improved Machine for making Thimbles for Rigging, &c.

Claim.—The arranging the two halves of the forming groove, upon the adjacent ends of two independent revolving mandrels or shafts, which are free to slide towards and from each other, so as to hold the two halves of the groove in contact, while the article is being shaped, and to separate the two halves of the groove, to allow the finished article to drop out; also the combination of the divided shaping groove, with a reciprocating former operating in connection therewith, as set forth.

Wm. A. Gates, of Mount Comfort, Tenn., for improvement in Cotton-Seed Planters.

Claim.—In combination with a rotary cylinder or box, having apertures in its perimeter, the projecting edges or wings, radial ribs or plates, and projecting fingers or prongs, arranged around the axle; the whole operating to separate or disentangle the seeds to be sown, immediately previous to the disposition thereof in the furrow, as set forth.

J. B. S. Hadaway, of East Weymouth, Mass., for improved Sash Stopper and Fastener.

Claim.—First, the combination of the rocking plate with the angular lever, the swinging lever, and the spiral spring, constructed and arranged and operating in the manner and for the purposes specified.

Secondly, the rocking plate combined with either a simple or compound lever, in the manner and for the purpose specified.

Robert B. Jones, of Birmingham, Pa., for improved Blind and Shutter Operator.

Claim.—The tubular shanked box-hinge, with roller contained therein, as arranged with respect to the roller within the building, when the rollers are connected by a chain, and the whole is constructed as described.

David Kennedy, of Reading, Pa., for improvement in Tanning.

Claim.—The use of borax in combination with nitre, alum, and terra japonica, in solutions of tannin, for the purposes set forth.

Edward and D. Kinsey, of Cincinnati, Ohio, for improvement in Bottle Stopper.

Claim.—The combination of the ball-stopper, together with the rod attached to it, and the guides, in the manner and for the purposes set forth.

Joel G. Northrop, of Syracuse, N. Y., for improvement in Cylinder Printing Press.

Claim.—First, such a combination and arrangement of a horizontal bed and cylinder of a printing press, as will enable each forward movement of a bed to impart a revolution to the cylinder, for the purpose of taking or giving an impression, and permit it to remain stationary during the reverse movement of the bed, as described.

Secondly, in combination with a horizontal cylinder moving in one direction, with alternate rest and motion, the inking and flying apparatus as described.

Prof. Adolph Richter, of New York, N. Y., for improvements in Perspective Drawing Apparatus.

Claim.—Delineating natural and other objects, in a diminished or increased size, with a lens, when used with the apparatus and in the manner described.

Steph. P. Ruggles, of Boston, Mass., for improvement in Printing Presses.

Claim.—Hanging or balancing the bed which holds the form and moves up and down for each impression, upon springs, so as that its own weight shall compress the springs to a great extent, and the entire compression of them be completed by drawing the bed farther down whilst in motion and so that the elasticity of the springs, when the bed is to rise, will raise it up to the extent of their power, and the upward motion be completed by a separate arrangement, whilst in motion, for the purpose of relieving the machine from overcoming the inertia in moving the bed from a state of rest, the power to complete its motion being applied near the termination of its movement, as described; also, the arranging of the frisket and the inking rollers in separate carriages, moving on the same ways, with such relative velocities as not to interfere with each other, and so that the frisket may carry off and bring back the sheet quickly, whilst the inking rollers may travel more slowly and do more perfect work, as described; also the pointing of the sheet, whilst being prepared for receiving the first impression, by an automatic movement attached to some moving portion of the press; also the application of a blast of air, or its equivalent, for the purpose of forcing the sheets upon the registering points, when the paper is being prepared for the reversed impression; also the removing of the sheet from the frisket, or from the press by means of atmospheric pressure, applied in the manner described; or its equivalent; also, making the registering points adjustable in the paper table, by passing it through a friction plate, secured between two plates; also, the combination of the open toggle and adjustable eccentric shaft or pin which operate the bed.

Cornelius Speer, of New York, N. Y., for improvement in Bracing and Supporting Card-Teeth.

I claim the application of the material herein described, to the front side of the leather fillet, holding the card-teeth, for the purpose of bracing and supporting said teeth.

Daniel H. Southworth, of New York, N. Y., for improvements in Serving Mallets.

Claim.—First, the attachment and use of the clasp or hook to the hollow or concave part of saddle of a serving mallet, for holding it to the rope while the operator brings the end of the marline from the spool over the pulley in the handle and upper edge of the saddle to the rope, where it is made fast without being wound round both saddle and rope.

Second, the attaching to a serving mallet one or more set of thumb screws, or any analogous devices, for the purpose of pressing upon the spool, for enabling the operator to serve the rope with any degree of tightness the yarn will bear, without winding it round both saddle rope and handle; the said screws being attached and operating in the manner and for the purpose described.

Daniel H. Wiswell, of Buffalo, N. Y., for improvement in Railroad-Car Seats.

Claim.—The employment of the double-jointed slides and jointed rods, with the jointed arms, jointed seat and back, pillars and supports; arranged and operating in the manner and for the purposes herein fully set forth.

Hezek. T. Jennings and Charles S. Collier, of Bethany, N. Y., and Thomas P. How, of Buffalo, N. Y. (assignors to H. T. Jennings and Charles S. Collier, of Bethany, N. Y., and Dorns Perry and Amenzo Beardsley, of Middlebury, N. Y., and Allen Hemmingway, of Perry, N. Y.), for improvement in Cordage Machinery.

Claim.—The regulating the speed of the receiving reel by the tension of the rope, as described.

Wm. F. and Nathan Davis, of Castleton, Vt., for improvement in Swing-ing Churns.

Claim.—The combination of the swing slotted board wheel, rock-shaft, and lever, for the purpose of producing two complete motions of the dash, from one full oscillation of the pendulum bars, substantially as described, to be denominated the "Oscillating Double-Acting Dash Churn."

Aug. Faulkner, of Walpole, N. H., for Pincers for operating Pile-Wires.

Claim.—The manner described of constructing and operating the claw, for withdrawing, carrying, replacing and releasing the figuring wires, viz., by making one of the jaws fixed, and providing it with a pin or projection extending into a suitable slot in the sliding part of the claw, so that as said part moves back and forth, in contact with the fixed part of the jaw, the pin or projection therein will, when the figuring wire is to be seized, keep it in position for being properly caught in the claw, and when it is to be released will prevent it from moving with the sliding jaw, as set forth.

E. C. Harmon, of Troy, Ohio, for improvement in Spaces for Setting Type.

Claim.—The cyma recta, or other more suitable shaped elastic space for facilitating the art of setting type, or for saving the time and labor usually expended in "spacing out," "thin spacing," regulating the distance of words in the same line from one another, and "correcting proof," in the manner set forth.

Geo. Hess, of Easton, Pa., for improvement in Fastening Palings to Rails in Iron Fences.

Claim.—The circular projection, or its equivalent, on the rail and lower part of the paling, in combination with a corresponding cavity on the lower rail, so arranged that by giving a partial rotation to said rail, the palings will be clamped to the rails, in the manner described.

Heman S. Lucas, of Chester, Mass., for improvement in Drying Paints.

Claim.—The process of treating magnesian mineral, such as serpentine silicates of magnesia and iron, and similar rocks, by mineral acids to prepare from the sedimentary or insoluble, or undecomposed portions of such rocks or mineral product, which I call a basis, to be used in the preparation of pigments, as set forth.

John H. Manny, of Waddams' Grove, Ill., for improvement in Harvesters.

Claim.—First, the arrangement of the track scraper and driving wheel, in such a manner that the latter, while the machine is cutting one swath, will run in the track cleared by the former, when the machine was cutting the previous swath, as set forth.

Second, the projections on the under side of the upper bars of the finger, in combination with the chamber or recess on the lower inside corners of said bars, to counteract the tendency of wire grass and other fibrous obstructions to pass in between the cutter-bar, and the sides of the recess in the upper part of the finger in which it is guided.

Third, forming the guard fingers of two parts, interlocked at the point, substantially as set forth, so that the grass cannot lodge in the joint and form an impediment to their entering between the stalks of the standing grain.

Fourth, in combination with a rocker stand or seat, a removable platform, constructed with a wing that extends from the outer end of the cutter, over the frame, and holds up the butts of the straws above the stubble, which otherwise would obstruct the discharge of the grain from the platform, substantially as set forth.

Chas. Montegue, of Pittsburg, Mass., for improvement in Printing Presses.

Claim.—Placing the bed-plate in a vertical position, when a reciprocating motion is imparted to it, by which the impressions can be made at each forward movement of the said bed-plate, as set forth.

I also claim the combination of the vertically acting bed, with a cylinder or cylinders, arranged in such a manner that the forward movement of the bed will impart motion to the cylinder or cylinders, to give or take an impression and allow said cylinder or cylinders to remain stationary during the return movement of the bed, substantially as set forth.

David Sadlier, of McWilliamstown, Pa., for improvement in Boot-Trees.

Claim.—First, the arrangement and combination of the levers, friction rollers, screw, and slide, or their equivalents, with the back part of the tree, which, when constructed, all bed closely therein, for the purpose described.

A. H. Cragin, M. Buck, J. H. Buck, and F. A. Tenney (assignors to A. H. Cragin), of Lebanon, N. H., for improvement in Printing Presses.

Claim.—First, the arrangement and combination of the movements, in connection with the bed, by which an extent of motion is imparted to the said bed, much larger than that of the sweep of the operating crank, whilst the whole of the said movements only occupy the space within the framework of the press below the bed, the pinion shaft having pinions upon it, which geer into stationary rack a a, made fast to the sides of the frame, and into racks c c, secured to the under side of the bed, the forked lever, or its equivalent, having its forked extremities connected to the said pinion shaft, and its opposite end jointed to the lever that rises from the oscillating shaft, and the pitman connecting the said lever with the crank on the driving shaft, or the equivalents of the said movements, when combined and operating as set forth; disclaiming, however, the principle of imparting motion to a printing press, by direct application of power to the bed.

Second, the combination and arrangement of the pressure cylinder and the bed with the conveying bands, nippers, and cams, for operating the said nippers, as set forth.

Third, the arrangement of the upper and lower tables with the pressure cylinder, bed, conveying bands, nippers, and cams, for operating the nippers in such a manner that an impression can be made at each right and left movement of the form under the cylinder, and the sheets be deposited after receiving their impressions upon the said lower tables, substantially as set forth.

D. C. Williams, of Madison, Ohio, for improvement in Whiffletrees.

Claim.—A shaft with the ends bent at right angles, and the lever making part of the same, arranged and operating as set forth.

J. J. Couch, of Philadelphia, Pa., for improvement in Machine for Drilling Stone.

Claim.—Making the drill-rod to slide through the piston-rod, as set forth.

I also claim the combination of the rocker-lever, the wedge, the bolt within the lever, the two cam-plates, the spring-catch, the spring, and a projection, as applied to the drill-shaft, the carriage or block, and the sideways thereof, and made to operate together, and to actuate the drill, substantially as set forth.

John Casewell, of Syracuse, N. Y. (assignor to Archibald C. Powell, of same place), for improvements in Machinery for Screwing Bolts, &c.

Claim.—First, the movable ways running in yielding bearings, back and forth, under the machine, and supporting the vise, as set forth.

Second, the adjustable stop or gage on the side of the friction nut, working in contact with the movable finger, or any similar projection in the die chuck.

Jeremy W. Bliss, of Hartford, Conn., for Attachment for Converting the ordinary into the Tapet Vise.

Claim.—An attachment to the vise, substantially as described, and for the purposes set forth, which attachment is removable at pleasure, and requires no change in the construction of the vise to which it is applied.

Wm. C. Finney, of Fayette County, Tenn., for improvement in Hoes.

Claim.—The extension of the blade of the common cotton hoe, upward and backward, in a curve, in such form and manner as to enable the laborer, by inserting his instrument and pushing it from him, to remove, by the cutting edge, any grass weeds, superfluous plants, &c., as described.

Jos. Guild, of Cincinnati, Ohio, for improvement in Mortising Machines.

Claim.—The sliding wrist connected with the chisel, and also with the driving power, in the manner described, in combination with the mechanism described, or its equivalent, for sliding said wrist, so that the operator can, during the motion of the machine, vary the depth of cut of the chisel, or cause it to be suspended without disconnecting the driving power.

John R. Moffit, of Piqua, O., for improvement in Endless Belts to Threshing Machines.

Claim.—The continuous open apron, having its belt formed of links, whose cogs are, at one part of their rotation (in connection with the pinions), or means of propulsion, and are, at another part of their rotation (in connection with the rollers or other stationary objects), a means of agitation of the said apron.

Fortunatus E. Richardson, of Hicksford, Va., for improvement in the Construction of Ploughs.

Claim.—Mounting the double-pointed share upon the central shoulder-piece, and fastening the same by a link-piece as described.

Horatio G. Sandford, of Worcester, Mass., for improvement in Rotary Knitting Machines.

Claim.—The combination of the mechanism termed the stop-motion, with the rotary knitting machinery of the kind, as specified, the object of the stop-motion being to arrest the operations of the machine on breakage of the yarn.

Daniel Tainter, of Worcester, Mass., for improvement in Rotary Knitting Machines.

Claim.—I do not claim the combining one or more draft rollers and a take-up roller, or drum, in one frame, which, when put in rotation, shall carry them simultaneously around with it, so as to draw forward and wind up a rope or cord, or like manufacture, formed of strands twisted together.

Nor the application of a take-up roller or mechanism as used on either a common warp or flat braid knitting machine; but I claim to so combine a draft, and take-up roller, and mechanism for revolving it, with a rotary series or set of needles and other mechanism of the peculiar kind mentioned for knitting, that such draft roller shall rotate simultaneously, or with the same velocity, with such series of needles, so as to prevent the longitudinal rows of stitches from being produced in helical lines, and the evil consequences resulting to the fabric therefrom.

Also the arrangement of the draft and take-up mechanism, in connection with the knitting mechanism, supported by two separate frames, and also their connection with the mechanism for producing an equal and simultaneous rotation of these frames, all substantially as described, whereby there shall not only be no connection between the frames to extend through the fabric, but no projection from the frames come in contact with the presser, stitch wheels, and cam bar, or their respective supports, during the simultaneous and equal rotation of both or either of the said frames.

Henry J. Ruggles, of West Poultney, Vt., for improvement in Cooking Stoves.

Claim.—The combination and arrangement of the front and rear flues and air chamber, as set forth.

Jacob and Freeman Wise, of Fredericktown, Pa., for improvement in the Manufacture of Stone and Earthen Ware.

Claim.—We claim, first, the mode of attaching the mandrel so that it may revolve on its axis, by means of friction with the clay, and at the same time be moved from side to side within the mould.

Second, the mode adopted for varying the relative thickness of the different parts of the manufactured article.

Wm. Hartell, of Kensington, Pa., and James Lancaster, of Spring Garden, Pa., for improvement in the mode of Generating Heat.

Claim.—The adaptation of, or rendering available tar as a fuel, for the production of the intense and steady heat required for the melting and manufacturing of glass, by introducing water or the vapor of water into the furnace in contact or in close proximity, or in combination or mixture with the tar, in the manner as set forth.

RE-ISSUE.

Cadwallader Evans, of Pittsburg, Pa., for Steam Boilers. Originally patented April 15, 1839.

I claim the combination of a fusible alloy confined in a cap-tube, or case, with a metallic stem, rod, or other fixture, not fusible at the melting temperature of the alloy, which stem, rod, or other fixture, is held or kept in position whilst the alloy remains hard; but when said alloy is fused, said stem, or its equivalent, can move or have motion, by which liberty to move any valve may be liberated, or caused to open and let steam escape, or any alarm may be let off, or any index moved, so that this combination may act as an alarm indicator, or safety apparatus.

Also, in combination with said alloy and plug, the heavy slotted weight, lever, or its equivalent, and safety or escape valve and its ordinary weight, acting in the manner and for the purpose described.

Eber C. Seaman, of Philadelphia, Pa., for improvement in Cream Freezers. Patented Oct. 3, 1848, and ante-dated April 3, 1848.

Claim.—The arrangement of two scrapers at an angle with the bottom and sides of the vessel, as described, so that the action of the rotation shall throw the scrapers against the sides and bottom of the vessel.

Mark Fisher and Wm. Martin, Jr., of Newport, Maine, for improvement in Welding Cast-Iron to Malleable-Iron or Steel. Patented Oct. 16, 1847.

Claim.—Uniting the steel and cast-iron as described, by first preparing the steel in the manner set forth, and then causing the cast-iron to flow over and upon the surface of the steel thus prepared, and in the manner and for the purpose set forth.

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Proceedings of the British Association at Belfast.

The following among other papers were read:

"On the Reconcentration of the Mechanical Energy of the Universe," by Mr. W. J. M. Rankine.—Mr. Rankine observed, that it has long been conjectured, and is now being established by experiment, that all forms of physical energy, whether visible motion, heat, light, magnetism, electricity, chemical action, or other forms not yet understood, are mutually convertible; that the total amount of physical energy in the universe is unchangeable, and varies merely its condition and locality, by conversion from one form to another, or by transference from one portion of matter to another. Prof. W. Thompson has pointed out, that in the present condition of the known world there is a preponderating tendency to the conversion of all the other forms of energy into heat, and to the equable diffusion of all heat; a tendency which seems to lead towards the cessation of all phenomena, except stellar motions.—The author of the present paper points out that all heat tends ultimately to assume the radiant form; and that, if the medium which surrounds the stars and transmits radiation between them be supposed to have bounds encircling the visible world, beyond which is empty space, then at these bounds the radiant heat will be totally reflected, and will ultimately be reconcentrated into foci; at one of which, if an extinct star arrives, it will be resolved into its elements, and a store of energy reproduced.

"On the Causes of the Excess of the Mean Temperature of Rivers above that of the Atmosphere, recently observed by M. Renou," by Mr. W. J. M. Rankine.—M. Renou having for four years observed the temperature of the river Loire at Vendome, as compared with that of the atmosphere, has found that the mean temperature of the river invariably exceeds that of the air, by an amount varying from 1½ to 3°, and averaging 2·24° centigrade, and a similar result has been deduced from observations made by M. Oscar Valin, on the Loire at Tours. M. Renou and M. Babinet account for this fact by the reradiation from the bed of the river of solar heat previously absorbed by it. Mr. Rankine thinks this supposition inadequate to account for the facts, because the excess of temperature of the river over the air was considerably above its mean amount in November, and very near its maximum in December; and because the mean diurnal variation of temperature of the river was much less than that of the air. He considers that friction is more probably the principal cause of this elevation of temperature; for if water descends in a uniform channel, with a uniform velocity, from a higher level to a lower, the whole power due to its descent is expended in overcoming friction; that is to say, is converted into heat, as the experiments of Mr. Joule have proved. This must cause an elevation of temperature, which will go on until the loss of heat by radiation, conduction, and evaporation balances the gain by friction, and at this point the temperature of the river will remain stationary.

"On the placing of Compasses in Iron Ships," by Capt. E. J. Johnson. While the *Trident* was in the basin at Woolwich, it occurred to me to try whether a position could be discovered where the influences of the ship's iron upon the compass were so equalized, as to render the amount of deviation so small as to be of no practical importance. The correct magnetic direction of the ship's head having been determined by a compass on the shore, and that proving to be near to one of the points of maximum deviation (the standard compass on the quarter-deck there indicating 20° *westerly* deviation), I moved the standard compass several feet further *forward* in the centre line of the ship, and there found the *westerly* deviation increased to 29°. I now commenced to move the compass aft six or seven feet at a time, observing the deviation at each position, and found the *westerly* deviation *decreased;* and on placing the tripod of the compass directly over the rudder-head, *easterly* deviation was produced; and hence it followed, that there must be a position somewhere between the last two places of observation where there would be no deviation while the ship's head remained in the same direction. This position I practically discovered by moving the compass a few inches at a time, till it indicated the correct magnetic direction of the ship's head. The question which now remained to be proved was, to what extent the deviations of the said compass had been lessened (or what they actually were) when the ship's head was placed upon different points; and I was gratified to find, that after swinging the vessel, and observing upon the eight principal points, the compass placed as before described proved to be correct within a quarter of a point. It is necessary to mention that the *Trident* has wooden beams under the quarter-deck, and therefore it remains to be seen to what extent such observations may be useful in vessels which have iron beams. It will also be requisite to ascertain, by actual observation, how far a position so selected shall prove advantageous when the ship changes her geographical position; and as the *Trident* is about to proceed to the southern hemisphere, and is amply provided with instructions and the means of ascertaining such changes, and as I shall swing her again at Greenhithe, on every point, before she leaves, we may hope for much useful information on this important subject. I must observe, that it may not always be practicable to find the position of no deviation, or where the influences of the iron in the ship upon the magnetic needle are equalized, because such a point might be found in a most inconvenient position, or be too near movable iron-work, machinery, &c.; but if we succeed in approximating towards it, and thereby reduce the deviations within moderate limits, a point of great practical importance will be gained in navigation.

"On some Properties of Whirling Fluids, with their application in Improving the Action of Blowing Fans, Centrifugal Pumps, and certain kinds of Turbines," by James Thompson. He pointed out several curious and interesting properties possessed by masses of fluids revolving in the circumstances of one of the most ordinary kinds of whirlpools—that, namely, which is formed when water is supplied at the circumference of a widely-extended vessel, and is allowed to flow away by a central orifice in the bottom. He showed that a consideration of these properties led to the conclusion, that the efficiency of centrifugal pumps, of fans for causing blasts of air, and of turbines discharging the water at the circumference, may be greatly increased by the provision, outside of the wheel, of a space in which the water may continue to revolve, without any interruption, after it has left the wheel. He stated that he had reason to believe that the centrifugal pump of Mr. Appold was so constructed as to take advantage of this principle; and added, that to this, its superiority over other centrifugal pumps appeared to him to be in a great degree due. He mentioned that an apparatus involving the same principle has been applied, with good results, in turbines of great power constructed in America.

"On an Instrument for obtaining correct Representations of Objects from Nature," by H. Twining. This little instrument was on the principle of a theodolite, by which the angular positions of the several objects in a scene in nature, which the artist had resolved to transfer to his canvas, could be accurately recorded in his note-book, and afterwards at leisure, by the aid of a square frame of crossing threads, accurately placed in a picture of any determined size.

Monthly Notes.

Ericsson's Caloric Engine.—In anticipation of the probable success of the hot-air engine, as developed by Captain Ericsson, we have now in the hands of the engraver a large copperplate engraving of this engine, carefully drawn to scale in every detail. Captain Ericsson has kindly promised the most complete facilities for illustrating and detailing both the construction and performance of this engine, at as early a day as will be consistent with the interests of the parties engaged in the enterprise. A general description, though necessarily quite imperfect, was published and illustrated in our first volume, pages 590 to 594, and any further examination of the principles and difficulties involved in its action would be somewhat premature, until the experiments now being made on so magnificent a scale are a step further advanced. Lying at her dock in Williamsburgh, her furnaces have been fired up and her wheels made to revolve at the rate of five revolutions per minute. This performance, while the ship is secured to the dock, has been computed by some engineers equal to about 10 or 12 turns per minute while under weigh, which, allowing for slip, would give a speed of nine or ten miles per hour, approximating that of our best ocean steamships. As, however, these relative values of revolutions in dock or in motion are matters much affected by circumstances, it may be proper to suspend judgment for a few weeks longer. The floats were smaller and the dip less than usual, tending to facilitate the turning of the wheels at the dock, but these circumstances are possibly more than counterbalanced by the increased diameter of the wheels and number of paddles, and also, so far as the relation between revolutions at dock and under weigh are concerned, by the fineness of the model of the hull.

But our reasoning on subjects of this nature, being based on the action of the steam-engine, may be widely at fault regarding the new application of heat, and few will volunteer conjectures with regard to the operation of the latter at different velocities. The regenerator, the main feature of the invention, "strains" the hot air of the exhaust through woven wires, leaving the *heat* of the air in the wires, ready to be imparted to the next breath, so to speak, of the engine. The fresh cold air is admitted through the same wires, and thus becomes heated nearly to the temperature required without any fuel. In this consists the economy of the invention. Now, it remains to be seen to what extent the air can be thus passed through successive disks of wire without so seriously retarding it as to "throttle" the engine. Beyond a certain point, the gain to be derived from a more complete transfer of the heat would be more than counter-balanced by the obstruction offered by the wires, and this point, with many others, can only be ascertained by practice. The success of the caloric engine will open a new page in engineering, compelling all to return to first principles, and humbly seek, by patient investigation and repeated experiments, those rules and deductions with regard to practical construction and management which have by the same means been so well established with regard to steam. There may be no fear, however, of a loss of employment on this account, as Americans are notorious for their ability to adapt themselves to circumstances; machinery will be more generally employed, both in its heavier and lighter forms, with each successive improvement, and perhaps nothing could give a greater impetus to the machine shops of our country than the triumphant and complete success of the caloric engine. We hope in our next number to record a favorable result of her trial trip.

Steamship "John L. Stevens."—This new steamship, designed to ply between Panama and San Francisco, performed her trial trip on the 7th ult. The Stevens was designed by and built for Wm. H. Aspinwall; the hull by Messrs. Smith & Dimon; the engine by Messrs. Stillman & Allen of the Novelty Works. Her dimensions are as follows: length of deck, 285½ feet; breadth of beam, 40 feet; breadth over all, 65 feet; depth of hold, 27 feet; and registers 2,500 tons. With 450 tons of coal on board, she draws 11½ feet water forward, and 12¼ feet aft. She has two steerage passenger decks.

The Stevens has one single oscillating engine, with wooden framing, puppet valves, and Pirrson's patent surface condenser; diam. of cylinder, 85 inches, stroke, 9 feet; two air-pumps, one 44 inch diameter, and 63 inch stroke, for the condensing water, and one 17 inch diameter, and 36 inch stroke, for the condensed water. The condenser has 2025 square feet of tube surface. The shafts are 18 inches diameter, at inboard journals. The wheels are 32 feet diameter, 16 arms, and 32 buckets, each 10 feet long and 20 inches deep.

She has two drop return flue boilers placed fore and aft the engine, each 14½ feet diameter of shell, and 23 feet long, with 54 13-inch flues in each boiler. Each boiler has three furnaces. Fire surface, 6100 square feet; grate surface, 164 square feet.

The performance on the trial trip was 15 revolutions per minute, with 14 lbs. steam, cutting off at one-third of the stroke; and a vacuum of 26½ in. The Stevens is now on the way to her place of destination.

World's Fair in Dublin.—Advertisements in the principal papers invite specimens of skill, industry, &c., from the United States to the Industrial Exhibition in Dublin, to open on the 5th of May next. The building, like those of the London and New York Fairs, will be made a bonded warehouse, and the British government, we are told, have undertaken to introduce an act of parliament for protection from piracy of new inventions. The secretary is J. G. Hallett, 113 Pearl-street; committee, Messrs. Theodore Sedgwick, Richard Bell, and C. Edward Habicht. Articles approved by them will be shipped without charge from New York to Dublin and returned.

Comparative Safety of Railways in Foreign Countries.—A correspondent of one of the morning journals gives the following summary of railway accidents: The number of passengers transported on the Prussian railways in 1851, was 9,901,681. Of this number, one person was killed by jumping out of the cars; four were wounded; four were killed; and three wounded by being on the track when the cars passed. Of officers and workmen in employ of the different companies, eighteen were killed and twenty wounded. One person was killed by voluntarily throwing himself under the wheels of the cars. In England, during the same year, the number of passengers was 78,969,623, of whom 36 were killed and 375 wounded. Sixty-one persons, not passengers, were killed, and fourteen wounded on the track. Of officers and workmen employed by the companies, there were 117 killed and 48 wounded. Four persons committed suicide by throwing themselves under the wheels of the cars.

War Steamer Princeton.—The Princeton will probably be again repaired or altered, her performance of late being altogether too feeble to enable her to sustain her part in the Japan expedition. At latest accounts, it was found impossible to maintain a pressure of over 6 lbs. of steam in her boilers when under way. The Princeton has been, if we recollect aright, three or four times furnished with new boilers and propeller, and is now furnished with a style of boilers, first introduced by the Peninsular and Oriental Steamship Company, and supposed to have been a considerable improvement. Tubular boilers will now be put in by Messrs. Murray & Hazlehurst, of Baltimore.

Railroad Brake.—L. Colburn, of Birmingham, Conn., has taken measures to secure a patent for a new railroad brake. This invention is a wrought-iron shoe, which is suspended on either side of the wheel in the ordinary manner, and worked like the common brake. It can also be used in cases of extreme danger by the engineer pulling a lever, which springs the knuckle joints of the shoes, and causes them to fall on the rail under the wheels, thus raising the latter slightly from the track and stopping them, as well as throwing the friction and wear on the shoes.—*Scientific American.*

Discovery of a New Metal.—Dr. Owen has discovered a new metal, holding an intermediate position between magnesia and manganese, for which the name thalium has been proposed. Its oxide, dissolved in hydrochloric acid, is of a beautiful pea-green color, and gives the following reactions:—Ammonia, a white, bulky precipitate, only sparingly soluble in sal-ammoniac; this is one of the characters which distinguish it from magnesia.—Phosphate of soda and ammonia: the vesicular precipitate caused by this reagent is quite peculiar, and forms one of the marked characteristics of this earth. If the phosphate be added without disturbing the liquid, a number of little vesicles are formed, which remain distinct. The earth, when pure, has the appearance of powdered, dried albumen. It has not yet been obtained in the metallic state.—*London Artisan.*

The screw steamship "City of Pittsburg," burnt in the harbor of Valparaiso on the 24th of October, had on board 1200 tons of Cannel coal, which is supposed to have taken fire spontaneously. It had been on board but a few days, and it was a fortunate circumstance for all concerned that the fire discovered itself in the harbor. An elaborate article on the spontaneous combustion of coal, which has destroyed a large number of splendid sailing ships on their way to California, would be particularly acceptable at this time.

To Readers and Correspondents.

The article on telegraphs in this number will be found of considerable interest, and will be followed by a general view of the same in foreign countries. The submarine telegraph between England and France has now been in successful operation for more than a year, and our next number will present the details of its construction. Those who may possess a copy of Bartol's Treatise on Marine Boilers may readily test for themselves the value of the rule for proportioning the fire-grates to marine engines, and those not so fortunate may find it worth while to notice the slight difference of the grates of the "John L. Stephens," see above, from that given by the rule. The valve movement, illustrated by the plate, and described page 10, is one which has excited in a high degree the admiration of engineers in this vicinity. As a piece of mechanism simply, the beauty and smoothness of its operation will well repay a close examination. The problem is, by a simple arrangement, to raise all the valves at the proper moment, and holding the exhaust valve open, to drop the steam valve at any desired time. There are several methods of accomplishing this. The Steven, the ordinary long-toe cut-off, may be, and we think has been, made adjustable; the Sickles cut-off is in extensive use, and highly and justly admired; and the Allen, on which the one in question is an improvement, although apparently quite complex, is really very complete and effective in its working. It is easy to literally "drop" any given valve at any portion of the stroke, but it is essential that the descent be easy and gradual. In Mr. Sickles' arrangement, the valve rod literally falls, but is checked as it approaches its seat by a plunge in a "dash-pot" filled with water or oil. In the Allen and Allen & Wells' cut-off, the motion is transferred at pleasure from a lifting to a gradually descending motion, and while always raised at the same instant, it arrives at its seat as early as desired, while the exhaust valves, not being thus transferred, remain open till lowered by the motion of the eccentric. The article on steam and locomotion will be important only to those who are not familiar with the principles of chemistry involved in steam generation, but being from a work not yet completed, and from high authority, may attract the attention of all, from the extent to which it carries the possibility of low temperature, the theories of heat, latent heat, &c.

We take this occasion to cordially invite the coöperation of all interested by volunteering communications or suggestions on those matters with which they are most familiar. Science is often the most perfect in those who know not the meaning of the word, and theory in those who pretend to despise it. Our invitation is not to those alone who have acquired distinction in the pursuit of truth, and are now resting on their laurels, but to all, in any capacity, who may have a suggestion to offer, or a correction to make of any thing which may be advanced in these columns. Facts briefly told are particularly desirable. Please to consider us as your particular friends, and address without reserve, as the name of a correspondent will never appear without permission.

APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 2.—Vol. III.—FEBRUARY 1st, 1853.

FORM AND SIZE OF SEWERS AND DRAINS.*

Increased Power of the Sweep of Water gained by Alterations in the Form of Sewers.

It appeared on examination that accumulations were greatly influenced by the shape of sewers, where the conditions as to run of sewer water or fall were the same. The trial works prepared in respect to sewers are here adverted to as illustrative, on a large scale, of the principles of construction previously noticed. Mr. Roe, surveyor of the Holborn and Finsbury division, who made one of the earliest advances in the improvement of the construction of sewers, had shown that, by an alteration of the form of sewer from a flat segment to an egg-shape—with the same quantity of water, at the same inclination—the deposit was reduced one-half. As a point of pecuniary economy accompanying improvement in construction, it was shown that the number of bricks required to construct a sewer, with upright sides, 75 inches long, would suffice for the construction of an egg-shaped sewer, with the same sectional capacity, 122 inches long.

Other examples might be adduced of improved results obtained by variations in form, without any change of the internal capacity of sewers.† The egg-shape possesses an advantage over the circular sewer in the increased scouring action derived from the greater rapidity of flow when the stream is small, and occupies only a small proportion of the area; and this is the general condition where sewers are made large enough for men to traverse them, without reference to the quantities of sewage which they have to convey; but it should be observed, that wherever good inclinations are obtainable, and the ordinary flow would be sufficient to keep the circular form of sewer clear of deposit, that form is to be preferred. It is stronger and more economical, it presents less frictional surface, and is more capacious, with the same amount of material. The special advantage of the egg-shape diminishes moreover with the size of the sewer, so that in the smaller areas it becomes scarcely appreciable. For pipe-sewers and drains the circular form is on the whole to be preferred, because the greater risk of unevenness of form, and the difficulty of obtaining the same accuracy of joint with the egg-shape, more than counterbalance the advantage of the small increase of flow which would be acquired. For intermittent purposes, where the house-sewage occupies only a small portion of the area, but the sewer is liable to be filled with storm-water, the egg-shape is undoubtedly the best. In proportion as the flow can be equalized and adjusted, and the principles of drainage reduced by practical science to an approximation of constants, to the same extent the egg-shape must yield to the circular, as the best form of sewer, without reference to size.

Increased Power gained by Alteration of size, as well as Alteration in Form of Sewers.

The following is an account of several trial works, and illustrates the effects of altering the size as well as shape of the channel of conveyance, with a better adaptation to the run of sewer water, and the service to be performed. It is contained in a report of Mr. Hale, the surveyor, who was directed to make the trial.

"The main line of sewer in Upper George-street is 5 ft. 6 in. high, and 3 ft. 6 in. wide, and runs from the Edgeware-road to Manchester-street, where it falls into the King's Scholars' Pond sewer. I have laid a 12-inch pipe 560 feet long upon the invert of this main line, and have built a head wall at the end of it, so that the whole of the sewage discharged by the collateral sewers above the pipe, as well as what sewage may find its way independently into the upper part of George-street, is forced to pass through the pipe. The whole area drained by the sewers running into the 12-inch pipe in George-street is 213,778 square yards, or about 44 acres. Observations are being continually made on the work, and the results are as follows:—The velocity of the stream in the pipe has been observed to be four and a half times greater than the velocity of the same amount of water on the bed of the old sewer.* The pipe has not been found to contain any deposit, but during heavy rains stones have been distinctly heard rattling through it. When the pipe is nearly filled, the velocity and concentration of the water are sufficient to clear away any matter which may have been drawn into the pipe from the large sewers, and much of which matter it may be presumed would never enter a well-regulated system of pipe-sewers; also the force of the water issuing from the end of the pipe is sufficiently great to keep the bottom of the old sewer perfectly clean for 12 feet in length; beyond this distance a few bricks and stones are deposited, which increase in quantity as the distance from the pipe increases. Beyond a certain distance, mud, sand, and other deposits occur to the depth of several inches, so that the stream there is wide and comparatively sluggish, and being dammed back by the deposit, exerts an unfavorable influence on the flow of water through the pipe. On the invert of the original sewer, which now forms the bed of the pipe, deposit was constantly accumulating, and was only partially kept under by repeated flushings. The superficial velocity of the water in the pipe is generally three, four, and five times greater than the superficial velocity which obtained *under the same circumstances*, in the original sewer, and the velocity of the *whole mass of water* in the pipe approximates much more to its surface velocity, as ascertained by a float, than does the velocity of the *whole mass* of water in the sewer approximate to its own surface velocity. On one occasion I had the sewer in Upper George-street carefully cleaned out immediately below the pipe, and then caused a quantity of deposit, consisting of sand, pieces of bricks, mud, &c., to be put into the head of the pipe; the consequence was, the whole of the matter passed clear through the pipe (560 feet long), and much of it was deposited on the bottom of the old sewer, at some distance from the end. When the pipe was flowing nearly half full, two pieces of brick, one weighing one pound and three quarters, and the other one pound thirteen ounces, were impelled by the force of the water through the whole length of pipe, and struck the legs of the man at the end of the pipe with considerable force. A live rat was also washed with great violence through the pipe, and struck the leg of a man with such force as proved the rat had no control over its own motion. When the water was only 5 inches deep in the head of the pipe, nearly a whole brick, weighing four pounds, was put in it; it was heard for a few seconds moving down the pipe, but was not caught at the end. The bulk of the stream at the head of the pipe

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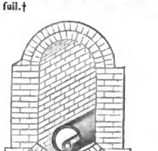
[*] General Board of Health.—"Minutes of Information collected with reference to Works for the Removal of Foul Water or Drainage of Dwelling-Houses and Public Edifices, and for the Sewerage and Cleansing of the Sites of Towns." Ordered to be printed for the use of Local Boards and their Officers engaged in the Administration of the Public Health Act. Presented to both Houses of Parliament by command of Her Majesty. London: Eyre and Spottiswoode. 1852.

[†] Narrow and deep channels frequently cut by streams in the surface of the soft deposit accumulated in flat-bottomed sewers, were demonstrative of the very little observation on which eminent engineers have declared that the form of the bottom of a sewer is of no consequence. It was declared at the outset of the investigation that a sewer with upright sides and wide-spreading footings was the best and most certain form of construction. The examinations directed in the subterranean survey have proved the erroneous doctrine in extensive failures of that form of sewer when carried through slippery ground. In some instances whole lines have been found driven in at the sides.

[*] As the force of a stream is proportionate to the square of its velocity, the cleansing power of the concentrated stream in the pipe would be above twenty times as great as that in the wide sewer, consequently stones, &c., which might rest in the latter would be swept away by the more rapid flow.

is diminished to about half its dimensions when it arrives at the end, the velocity being greater. A great number of irregular-shaped stones, each of several ounces weight, were washed through the pipe with the same apparent ease as marbles, and the distinct rattling noise I occasionally heard them make might convey a correct notion of the considerable force with which they must have been impressed. All the foregoing results were effected when the pipe was either only half full, or less than half full of water, which has been gaged in the pipe. The house-drains connected with the experiment in George-street are in most respects like the rest of the house-drains of the metropolis; the general characters of the whole are great size, irregularity of form, and filthy and bad-smelling condition. The variations in size are from nearly half a square foot to four square feet cross-section, and the different forms include the circle, the square, and square bottom and sides with semicircular top; their inclinations seem not to vary more than from horizontal to a fall of two inches in ten feet. Their condition with respect to quantity of matter deposited in them does not seem to be regulated by their inclinations. This may be accounted for by the fact, that their wide and irregular inverts spread the small streams and destroy their force, and cause matter to lodge with greater security. Many of the ends of the drains are so dilapidated, that their original form cannot easily be distinguished; but enough can be determined to know that the sum of all their areas (480) would exceed the area of a circle of 30 feet in diameter. Much of the rubbish and obstructions in the house-drains have been found to consist of heaps of pieces of brick and mortar which from time to time have fallen from the soffits and sides of the drain, as it has progressively become dilapidated. Various species of fungi shoot out from the interstices of the brickwork; and the existence of old cobwebs around the sides, and sometimes nearly covering the mouth of the drain, furnishes another proof, in some instances, that the drain has not been for a long time, if ever, half filled with water. These old drains are the special harbors of rats and other vermin."*

It may be here observed that vitreous pipe-sewers, if properly made, will bear very considerable internal pressure. The smaller-sized stoneware pipes have been tested to several hundred feet. Common redware clay pipes of 6 inches have been tested to between 100 and 200 feet of pressure. Pipe-sewers and drains, properly laid, and cemented with Roman cement, may therefore be used under pressure. Experience, as well as a consideration of the difference of structure, shows that it is not safe to use sewers of the common brick and mortar construction full.†



The above is a view of the sewer in which another trial work was most carefully conducted by Mr. Lovick, surveyor, to determine accurately the amount of sewage from 1200 average-sized houses in the metropolis on the days when there was an intermittent supply of water from the different water companies.

In this sewer, which had a flat segmental bottom 3 feet wide, a sectional area of 15 feet, and an average fall of 1 in 118, the deposit from the 1200 houses regularly accumulated at the rate of 6000 cubic feet per month. But a pipe of 15 inches diameter placed along the bottom of this sewer, with a somewhat less inclination (1 in 153), kept it perfectly clear of deposit. The average flow, without rainfall, was about 51 gallons per house per diem; the absolute drainage, apart from rain-water, from all the 1200 houses would have passed through a 5-inch tube (of the relative size of the smaller one shown within the 15-inch tubular pipe placed along the bottom of the brick sewer), or not one-third the area of the minimum-sized drain which had, up to the time of the investigation, and upon the advice of professors of architecture, been declared and enacted in the Metropolitan Building Act to be necessary for a single house—namely, one of not less than 9 inches diameter. On the same rate of flow, the whole of the mere house-drainage from all the houses in the metropolis might be discharged through a sewer of three feet in diameter.*

Adjustments of the Sizes of Tubular House Drains and Main Drains required for the Discharge of Storm-Waters.

Whilst the drains for the discharge of soil-water from within houses are made of 3 or 4 inches diameter, the main-drains and sewers will require some enlargement (beyond the space required for the ordinary waste-water from the houses) to receive variable quantities of rain-water.

The necessity of provision for the reception of these variable quantities of water was alleged as one justification of the enormous sizes of the sewers as, until recently, constructed; but on examination the data were found to be wholly insufficient to warrant such dimensions.

The greatest storm which need be considered—such a storm as occurs in England only in the course of years—would be a fall of about 2 inches in the hour, or 44,789 gallons per acre. Now, it was proved by the trial works that a *three*-inch tube, at an inclination of 1 in 120, will clear away more than this amount of rain-fall from 10 squares, space enough for three laborers' cottages, classed as fourth-rate houses under the Building Act in the metropolis; at a fall of 1 in 80, it was found that it would clear away the rain-fall from 12 squares, or one first-rate and four fourth-rate houses; at a fall of 1 in 40, from 17 squares, or five fourth-rate houses; and with a fall of 1 in 20, it would serve for 25 squares, or the space of two first-rate houses, or eight fourth-rate houses. A 4-inch tube would carry away nearly twice as much water $(\frac{16}{9})$ as one of 3 inches diameter; that size is therefore, for such an area, more than sufficient for the greatest contingency.

Observation of the flow of any outfall of storm-water, and of the tributaries from a hill-side, offers to an unscientific person some approximate conception of the sizes of the channels or tubes which would be required to convey it away; so in a town, the observation of the flow of storm-water in the rough kennels or channels of streets, where there is no under-drainage, would be suggestive of the maximum sizes of the underground sewers required for its removal. But it was found on investigation that for side-streets and streets where the storm-water never rises above the side gutters, enormous sewers had been constructed of a capacity sufficient to receive water enough to cover the whole surface several inches deep, and to give it the appearance—which it never had—of a river.

The occasional bursting of large sewers has been referred to as a proof of the necessity of their large size for the discharge of storm-waters; but it appeared upon investigation that the burstings were caused by accumulations occasioned by the large sizes of the sewers, by their irregularly-constructed bottoms, their junctions at right angles, and by other causes. On the occurrence of a sudden storm, one accumulation is rapidly driven up the incline of another, occasioning a complete stoppage. When the internal condition of the sewers was examined at the places where these burstings occurred, it became a matter of surprise that such accidents had not even more frequently happened.

One plea often urged in justification of the extravagant sizes of the old drainage works, even for lines of streets in which but little extension could be reasonably expected was, that they were made so large to meet an assumed probable extension of the population. Such outlays are open to the objection that immediate and certain levies ought not to be made upon the present population to provide for contingencies remote and uncertain. It is overlooked in such expensive provisions that the reduced rates at which improved works may be constructed, as compared with former defective works, will pay for their removal within very short periods. Further, it is presumptuous to say that no improvement can be reasonably expected upon existing works, and that they will forever be the most eligible. Moreover, the plea cannot be sustained, even as regards the future, for reason has been generally found for believing that the same lines of sewer would admit of considerable additional heads of water without any increase of size whatsoever.

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* An inquiry was directed to be made as to the expense of laying down a mile of 16-inch pipe in an old sewer, with junctions of 4-inch branch pipes to every house-drain made good, when it was estimated that the expense would be 254l. 14s. 5d. per mile; and it appeared that in many such situations as those, where, according to the views of various engineers, cleansing by flushing or hand labor would be required, such a line of pipe would keep the sewer entirely clear of deposit, and, so far as the sewer itself was concerned, clear of smell, while it would greatly diminish, if not prevent, the circulation of foul gases from the house-drains through the sewers. According to the report of Mr. Lovick, the present expense of flushing in some districts is 2l. 10s. per mile per week. In the newly-cleansed districts it was 28l. per annum per mile. Even this expense was owing to old accumulations now in course of removal. In the Holborn and Finsbury division, where the flushing is regular, the average expense of keeping the sewers clean by flushing, at piecework, is 17l. 5s. per mile per annum. Now, the total cost of such a tubular sewer as that above described by Mr. Hale, allowing for a 16-inch pipe instead of a 12-inch one, and spreading the payment over twenty years, would not be more than 10l. 8s. 5½d. per mile per annum, if executed on a large scale at the prices therein described. Under the flushing system in the least uncleanly sewers district, the expense of flushing represents the expense of removal of 517 loads of detritus and decomposing refuse at 6d. per load, spread in portions over a mile of surface 3 feet wide on the average, until it is removed at weekly and fortnightly intervals. At an extra annual expense of 2l. 3s. the retention and spreading of a proportionate part of these 517 loads may be prevented in streets where there happens to be a sufficient fall.

† With respect to a great number of the recently-built and most expensive brick sewers in the metropolis, it is reported by the officers engaged in the subterranean survey, "that with one-fourth the strength of a man you may drive a searcher through the brick-work and several feet beyond; then, by using the searcher as a lever, you may shake the whole sewer for a yard round," and that the works cannot be reasonably expected to stand for more than ten or twelve years, much less any full flows of storm-water.

* It will be obvious that by this calculation it is not intended to convey the meaning that a 3-feet sewer would suffice for the drainage of the metropolis, but merely that assuming the average of the whole of the house-drainage alone to be that which was found in this experiment, and that the whole were flowing in one channel at the same rate, a 3-feet sewer would suffice to convey it.

The provision of extra capacity for such purposes has, however, been frequently made on the assumption that the increased area required would be proportional to the population, whereas it appeared that an additional head causes, by the increased velocity, the discharge of the additional quantity through the same sized sewer; an effect not then understood, but which was displayed in the trial works. It would be in exceptional cases only that the drainage area would be increased with increase of population.

Neither is the formation of a *whole* system of sewers of extraordinary sizes justifiable on the pretext of their being required on the occurrence of extraordinary storm-waters.

In many cases an increase in the number of the higher branch lines may ultimately necessitate an increased size in the valley-lines; but in respect to all the branch lines it may be concluded that the concentration and economy of the ordinary flow, and the most rapid and complete daily sweep of the sewers preponderates in importance over the inconvenience occasioned by extraordinary storms, occurring at intervals of many years, and sometimes only at intervals of generations, such as the storm which fell upon parts of the metropolis in 1846, of 4 inches in the hour.

Various formulæ were presented to the Commissioners for inquiring into the means of improving the Health of Towns, as furnishing the means of obtaining greater certainty in the construction of town sewers, and plans for the sanitary improvement of large town districts were prepared upon those formulæ; but the sewers thus designed were still so large, and consequently so very expensive as to offer very formidable obstructions to the extensive voluntary adoption of works of sanitary improvement. These plans were apparently thought repugnant to common and empirical observation of natural outfalls of the nature above referred to, and therefore it was found necessary that trial works should be instituted for the better determination of the proper sizes. The chief results of these trials, made with the smaller and more manageable channels for the removal of sewage or drainage water, have been already described in the evidence cited. In respect to the larger channels, the branch and main sewers, there occur elements not ascertainable by any readily manageable trial works; such could be determined only by observation from an ascertained rain-fall upon a given town area how much did really reach the outfall, and within what time.

To test compendiously the statements as to the alleged necessity of such large sizes for the removal of varying quantities of storm-water, observations were directed to the flows of water at the outfalls from large districts after rain. The following portions of an examination of Mr. Roe exemplify the course and results of these investigations:

"Has carried on a set of practical observations as to the flow of sewers of different sizes and capacities under different circumstances, ever since he has been in the service of the Commissioners of Sewers for the Holburn and Finsbury divisions. Has carried on observations as to the velocities of water in the river Fleet sewer; subsequently he extended his observations to branch and collateral sewers of different descriptions. About 4400 acres are drained by the river Fleet, of which 1888 acres are covered, or town area, and 2512 acres uncovered, or rural area. The Fleet sewer is 12 feet high and 12 feet wide, with a sectional area of 120 feet in the largest part in the Holburn and Finsbury divisions; but the capacity of the whole line varies generally according to the quantity of surface drained by each portion. With regard to its inclination, it varies from 1 inch in 100 feet to 1 inch in 2 feet, whilst some portions are on a level. The sum of the capacities of all the sewers that fall into it is about 550 feet, and they are sixty in number. The capacity of the main is about 1 to 4 of the capacity of the sewers, of which it is the general outlet. The average inclination of the sewers which fall into the Fleet in most instances varies; some of them are a quarter of an inch in 10 feet, others are 3 inches in 10 feet. If every house within the district had a drain of 9-inch diameter, the proportion the capacities of the house-drains would bear to the sum of the capacities of all the sewers would be about 16 to 1, and to the capacity of the main outfall about 75 to 1.

"Engineers and theoretical writers have set forth various formulæ as to the flow of water; and in the Second Report of the Health of Towns Commission there are some tables, by Mr. Hawksley, on the capacity of sewers required for various areas of drainage. Taking table No. 1, witness finds that the sizes recommended for sewers to drain certain portions of land are larger than the actual requirements; for, instance, the quantity of acres that a cylindrical sewer 48 inches in diameter is (by the table) allowed to drain, when the inclination is 1 in 240, is 47; whereas in practice it is found that such a sewer, with that inclination, drains more than 100 acres of town area at a similar fall of rain to that on which the table is formed. Again, a sewer, with a similar inclination, to drain 129 acres of town area, should (by the table) be of the capacity of about twenty-eight feet; but in the great storm of August, 1846, the water from 215 acres of town area, and 1785 acres of rural district, occupied only 30½ feet of the superficial area of a sewer with that inclination. With respect to larger sizes, the table shows, that at an inclination of 1 in 480, a sewer to drain 329 acres of town area should have a capacity of about 78 feet; whereas, in a sewer with a similar inclination, the area occupied in the storm of 1844 was only 79 feet; and to this sewer there drained 1181 acres of town area, and 2656 acres of rural district."

In the formation of the tables for showing the proper size of sewers it has usually been assumed that a certain large proportion of the rain falling upon a town area will flow into the sewers as quickly as it falls, and that the channels for its conveyance ought to be large enough to carry that quantity away, supposing it all to enter at the head. Mr. Roe finds from long-continued observations that a very much smaller part of the rain runs off into the sewers in the same time than has been assumed (*i. e.* that very heavy falls of rain are much shorter in continuance than the floods they occasion), and that sewers receiving along their course the confluence of many smaller channels will convey away far more water than if it all entered at the head. He consequently finds that sewers of much smaller section than the usual tables indicate are amply sufficient, and therefore that the use of such tables, or of the formulæ on which they are constructed, has led to large unnecessary expenditure.

Since Mr. Roe gave the evidence already cited, he has been compelled by illness to resign his office of chief surveyor to the Metropolitan Commission of Sewers; but he has since his retirement, and during his convalescence, occupied himself in completing for the Board a table of dimensions of sewers, founded upon his observations, in the Holburn and Finsbury district of the metropolis, of branch as well as main lines of sewers—observations the most extensive of any which have yet been made. The runs of water through the smaller-sized pipes are corroborated by the results of trial works, promoted in pursuance of the investigations directed by the Metropolitan Sanitary Commission.

The discrepancies of the formulæ adopted by various eminent authorities for calculating the run of water through pipes are well known. Some mathematicians appear to have deduced their constants from experiments on a scale so small as could be tried in a room, and to have assumed that empirical formulæ so obtained were of universal application; but the results of such calculations are frequently at variance with fact and with each other. And correct though certain formulæ may be for determining the discharges of water through simple pipes or channels under certain conditions, it is quite certain, from all the most recent and careful investigations, that the ever-varying conditions connected with the complete drainage of a town or district renders the application of any of the formulæ hitherto used not merely impracticable but productive of serious constructive error. The objections to the use of all the tables prepared from such formulæ for determining the sizes of sewers were stated in evidence before the Metropolitan Sanitary Commission. Their entire inapplicability for this purpose is strikingly confirmed by Mr. Roe's table, founded upon the only observations of considerable extent in the sewers themselves which are known to have been yet made; and the circumstances of the flow in the larger sizes, and of most extensive lines of sewers, are such as could be corroborated by no trial works attainable with any available means, or within reasonable time and cost.

The size of a stream which would be produced by a given fall of rain, upon a given area, admits of calculation, assuming that all or a given proportion of the water arrives at the drain at a given rate; but it would appear that notwithstanding the enormous expensiveness of drainage works, persons directing the outlay had never determined by actual observation the greatest rate at which the water did really run off, and consequently did not know of what size drains should be made.

The proportion of the flow which actually reaches the sewers differs greatly under different circumstances of season, soil, and surface, and especially of different rates of rain-fall in a given time. In long-continued rains, and in heavy storms, for which the table is calculated, a much larger proportion reaches the sewers than on ordinary occasions, the greater flow from the covered portion of the surface usually having time to pass away before the rain falling on an absorbent surface of garden, meadow, or arable land, reaches the sewer.

The following is Mr. Roe's table, and his account of its formation:

TABLE *showing the Quantity of Covered Surface from which Circular Sewers (with Junctions properly connected) will convey away the Water coming from a Fall of Rain of One Inch in the Hour, with House Drainage, as ascertained in the Holborn and Finsbury Divisions.*

	DIAMETER OF PIPES AND SEWERS IN INCHES.											
Inclination.	24	30	36	48	60	72	84	96	108	120	132	144
	acre	acre	acre	acre	acre	acre	acre	acre	acre	acres	acres	acres
Level, . . .	39½	67½	120	277	570	1020	1725	2850	4125	5825	7800	10100
¼ in. in 10 ft., or 1 in 480, . .	43	75	135	308	630	1117	1925	3025	4425	6250	8300	10750
½ in. in 10 ft., or 1 in 240, . . .	50	87	155	355	735	1318	2225	3500	5100	7175	9550	12400
¾ in. in 10 ft., or 1 in 160, . .	63	113	203	460	950	1692	2875	4500	6575	9250	12300	15950
1 in. in 10 ft., or 1 in 120, ...	78	143	257	590	1200	2180	3700	5825	7850	11050	14700	19085
1½ in. in 10 ft., or 1 in 80, ...	90	165	295	670	1365	2456	4225	6625				
2 in. in 10 ft., or 1 in 60, . . .	115	182	318	790	1500	2675	4550	7125				

"The table is formed from results obtained from observations extending over a period of twenty years in the Holborn and Finsbury divisions. In some instances the observations were carried on during the whole period of heavy rains, being commenced as each storm began, and continued until the effect had ceased in the sewers, the depth of water being taken every five minutes, and the velocity of the current repeatedly noted at every depth. In some instances the observations were continued day and night for several months in different years, and in others they were conducted day and night for a period of two years; rain-gages being kept to ascertain the depth of rain that fell. The particulars from which the table is compiled fill upwards of 100 memorandum books. The first saving which these observations enabled me to make was about £4000, by lessening the size of a proposed portion of main line, by which a reduction of two guineas per foot lineal was effected in a length of nearly 2000 feet. In other sewers of smaller size, savings were effected to the amount of several thousands per annum for many years. In 1843, I was called upon to report on the best means of saving the town of Derby from the disastrous effects of floods. It was from the knowledge obtained during the course of these observations, that I was enabled to suggest the size of sewers which would convey the flood-water of the Markeaton brook, the overflowing of which shortly before had not only caused damage to the amount of many thousand pounds sterling, but also loss of life. From the time of the completion of the sewer to this date, it has answered every expectation, no flooding having been complained of, although in August, 1846, more rain fell in a short space of time than I find on record at any other period. This knowledge also enabled me to judge of the size required for a main line of sewer in the town of Birmingham some years since, and which has also answered every requirement. The necessity of carefully forming the sewers, so that no obstruction to the passage of the water may obtain, cannot be too strongly impressed on the minds of all connected with such works. At the head of the table I have named, 'junctions properly connected,' nor will the respective sewers drain the area stated, unless this important matter be duly attended to. Every junction, whether of sewer or drain, should enter by a curve of sufficient radius. All turns in the sewers should form true curves, and as, even in these, there will be more friction than in the straight line, a small addition should at curved points be made to the inclination of the sewer. I may mention a case or two in illustration. In 1844, a great quantity of rain fell in a short space of time, overcharging a first-size sewer and flooding much property. On examination, it was found that the turns in the sewers were nearly at right angles, and also that all the collateral sewers and drains came in at right angles. The facts and suggested remedy were reported to the Holborn and Finsbury Commissioners, and directions given by them to carry out the works. The turns and junctions were formed in curves of 50 feet radius, and curved cast-iron mouths put to the gully-shoots and drains; the result was, that, although in 1846 a greater quantity of rain fell in the same space of time than in 1844, no flooding occurred, and since then the area draining to this sewer has been very much extended without inconvenience. In another case flooding was found to proceed from a turn at right angles in a main line of sewer. This was remedied by a curve of 60 feet radius, when it was found that the velocity of current was increased from 122 (as it was in the angle part) to 208 (in the curved part) per minute, with the same depth of water. In the winter season, on meadow ground 82 acres in area, having a clay subsoil, 3 feet per acre per minute was the greatest quantity that came at one time from a fall of rain of half an inch in depth, and this amount did not reach the sewer until three quarters of an hour after the rain had ceased. From similar ground during the summer, when a greater fall of rain took place, no water ran off the surface, and that which percolated to the land-drains did not reach the sewer until after the greatest flow from the streets and houses had passed away. In applying the table to localities where the inclination of the surface is greater than that of the Holborn and Finsbury divisions, a modification of the sizes of sewers will be required; for instance, in one case that came under my notice, where the general inclination of the surface of the streets was about 1 in 20, the greatest flow of water from a thunder-storm came to the sewer at the rate of one-third more than it did to a sewer draining a similar fall of rain from an area with a general surface inclination of 1 in 132."

In examining this table, two points of error must be guarded against, into which the ordinary calculations would lead, and which constitute the striking difference between the results here noted, and those which have been hitherto put forward for guidance; namely, the error of calculating the discharges obtained only from pipes running full at the head; and the error of assuming, without observation, that the given quantity of rain falling in a certain time would be discharged within the same period.

The effect of junctions on the line of sewer constitutes a most material difference in the discharge. The experiments and observations show, that with a pipe laid at an inclination of 1 in 60, with junctions along its line, the capacity of discharge is upwards of three times greater than if the flow were merely from a full head; and in the larger sizes it will be found that the quantity accumulated increases to upwards of eight times that which would be discharged if received only from a full head. If the area is lengthened and distant, with little inclination towards the main, and there is a considerable portion of rural area, the conveying sewer may be proportionately less. In such cases the flow from the nearer portion of the district will frequently have been discharged before that from the distant area will have reached the main, and at all times the rain-fall on the rural portion will be proportionately longer in reaching the sewers.

It should be observed, that although the actual sizes given in Mr. Roe's table would more than suffice for the drainage of the areas stated, with the houses thereon, yet in relation to the smaller sizes, for the drainage of courts and collections of houses, some modifications will be found necessary. In these cases, many of the reasons alluded to, which are seen to operate in great reduction of size of sewer for larger areas, and for space from which several connections would be formed, more or less distant, will not be in action. The rain-fall from the smaller spaces will flow more immediately to the drains, and their capacity must be equal to its discharge with corresponding suddenness. The pipes themselves, moreover, are often not of the full sizes which they are stated to be, and their greatest effect is not obtained from unevenness of form. The risk of carelessness in laying and jointing is greater also in the smaller sizes, where it is of the most importance, and operates still further in reducing the available capacity of the pipes. These points have so far influenced the practice that 3-inch tubes have scarcely been used hitherto, except for branch house-drains. For these reasons it is considered advisable to admit of greater margin in the calculation of the sizes for this purpose; and the following separate table has been prepared by Mr. Roe for special application to house and court drainage.

From this table it will be perceived, that the sewer formerly proposed as the smallest size admissible for the drainage of a "mansion," viz., 15 inches, would at a fall of 1 in 120, drain 79 of the largest mansions, or 284 of the smallest houses; that a 9-inch drain (the minimum size prescribed by the Building Act, for the drainage of a single house), would at the same gradient remove the storm-water from 21 of the largest mansions, or from 76 of the smallest houses; or, at a fall of 1 in 60, would drain nearly 100 of the smallest, or an area of nearly 2¾ acres of covered surface.

An 18-inch sewer, less than that prescribed as the minimum size

TABLE *showing the Size and Inclination of Main House-Drains for given Surfaces, and the Number of Houses of either Rate thereon, calculated from Mr. Roe's Table for a Fall of Rain of two inches in the Hour, as obtaining in the Holborn and Finsbury Divisions.*

Surface occupied.		Number of Houses of either rate, either of which may respectively be drained.				Diameter and Inclination of Tubes.									
Acres	Squares of 100 feet.	1st.	2d.	3d.	4th.	3-inch.	4-inch.	5-inch.	6-inch.	7-inch.	8-inch.	9-inch.	12-inch.	15-inch.	18-inch.
$\frac{1}{8}$	54	1	2	3	4	1 in 120									
$\frac{1}{4}$	112	2	4	6	9	1 in 20	1 in 120								
$\frac{7}{16}$	195	3	7	10	15	. .	1 in 40								
$\frac{1}{2}$	224	5	8	13	18	. .	1 in 30	1 in 80							
$\frac{9}{16}$	265	5	9	15	21	. .	1 in 20	1 in 60							
1	448	10	15	26	36	. .	. .	1 in 20	1 in 60						
$1\frac{1}{5}$	528	11	17	29	40	. .	. .	. .	1 in 40	1 in 120					
$1\frac{4}{9}$	648	15	23	39	54	. .	. .	. .	1 in 20	1 in 60	1 in 120				
$1\frac{4}{5}$	814	19	28	49	67	. .	. .	. .	. .	. .	1 in 80				
$2\frac{1}{16}$	912	21	32	55	76	. .	. .	. .	. .	. .	1 in 60	1 in 120			
$2\frac{4}{9}$	1094	25	38	65	90	. .	. .	. .	. .	. .	. .	1 in 80			
$2\frac{9}{10}$	1300	27	42	71	99	. .	. .	. .	. .	. .	. .	1 in 60			
$4\frac{2}{5}$	1970	45	68	117	162	. .	. .	. .	. .	. .	. .	. .	1 in 120		
$5\frac{3}{16}$	2308	52	79	136	189	. .	. .	. .	. .	. .	. .	. .	1 in 80		
$5\frac{2}{3}$	2534	59	88	150	208	. .	. .	. .	. .	. .	. .	. .	1 in 60	1 in 240	
$7\frac{2}{3}$	3432	79	118	205	284	. .	. .	. .	. .	. .	. .	. .	. .	1 in 120	
9	3976	90	135	234	324	. .	. .	. .	. .	. .	. .	. .	. .	1 in 80	
10	4404	101	152	263	364	. .	. .	. .	. .	. .	. .	. .	. .	1 in 60	1 in 240
17	7400	169	253	439	608	. .	. .	. .	. .	. .	. .	. .	. .	. .	1 in 120
$19\frac{7}{16}$	8700	200	300	520	720	. .	. .	. .	. .	. .	. .	. .	. .	. .	1 in 80

into which a man might crawl for cleansing, would, at an inclination of 1 in 80, remove the storm-water from nearly 20 acres; and a sewer of 3 feet (less than the minimum size formerly recommended for the smallest street), would, at the same inclination, remove the drainage from 295 acres.

In distributing the inclinations, which a given fall in any continuous length will admit of, it should be borne in mind that it is always desirable to graduate them, so that the utmost inclination which may be practicable should be given to the upper part of the line, where there will be the less current and force of sweep. The drains should always be laid at the greatest inclinations which can be obtained; and this should always be kept in view, therefore, in selecting the sizes from the table. The sizes of the drains will require modification according to variations in the area and inclinations of the ground, and the number of houses to be provided for.

Lake's System of Canal Steam Navigation.

YESTERDAY we were present at a series of experiments performed on the Grand Junction Canal, near the town of Leighton Buzzard, Bedfordshire, the object of which was to exhibit, on the scale of actual practice, the efficiency, economy, and general advantages of the system of steam navigation proposed for canals by Mr. John Lake, C. E., for which that gentleman obtained letters patent on the 8th of December last. The spot selected for the experiments is characterized by several local peculiarities which render it admirably suited to the display, in their full effect, of the great resources of this project; as there is probably not another in the entire length of the canal where greater engineering difficulties could be brought together, so as to assure the spectator that the experiments he witnesses are proceeding under the most rigorous circumstances that could present themselves. It is situated at the distance of about a mile and a half on the London side of Leighton, at a place called Grove. An extent of half a mile of the canal has here been placed at the disposal of Mr. Lake by the directors of the company; and as the width is sufficiently great to admit of the old and the new systems being worked side by side, the strong contrast existing between the merits of the two is the better seen and appreciated. Within this short experimental piece we have, towards its northern extremity, an extremely sharp curve, and, about the middle, a rise, by a lock, of 7½ feet, approached by another curve, though of smaller radius. At this point there is a double lock, through one of which—that on the up side—the ordinary traffic of the canal still flows. The gates of the other have been removed, and their functions superseded by an inclined plane, constructed on the principles laid down in Mr. Lake's specification. Beyond this the experimental line is continued for a considerable distance at the higher level, first in a straight, and then in a curved direction.

The substance of Mr. Lake's invention admits of being concisely stated, from its extreme simplicity, and we propose to give a succinct account of it in this place, that the results already accomplished by it may be fully appreciated. First, the permanent way of the works in every level section of the canal consists of a double line of light iron rails, supported at the uniform height of about 18 inches above the usual high-water mark, upon parallel walings, or beams of wood, to which they are attached by countersunk screws. The walings follow the course of the canal and rest upon rows of piles driven into the bed of the canal, about 15 feet apart. Within the trackway thus formed a number of canal boats with square ends are brought together, and coupled rather closely, so as to constitute a train. Immediately in front of them is another boat, which contains the engine by which motion is to be communicated to the train. The piston-rods of the engine are directed upon cranks in a transverse shaft, which carry the driving-wheels, by the reaction of which upon the rails the whole train is set in motion. In order to produce the requisite tractive force, the driving-shaft is pressed downwards to the rails by a pair of levers, through which it passes freely, and which lie in the direction of the rails. The after ends of these levers are attached strongly to fixed points in the engine-boat, while their other ends are united by a transverse beam of iron, which can be raised or depressed by means of a powerful screw and lever. When the transverse beam is depressed, the driving-shaft and its wheels are pressed down upon the rails, and the engine being set in motion, the entire train of boats is drawn along. On level canals, or those without locks, the arrangements described are all that would be necessary in actual practice; but to raise the train from one level to another, an inclined plane of extreme simplicity and perfect efficiency has been proposed by the inventor, which at once does away with the loss of time, water, and enormous expenditure incidental to the present system of locking. This incline is, in fact, a double one. The walings ascend upon the heads of piles gradually increasing in height, and strongly framed together in both directions. As the engine would be utterly powerless to draw its train up even a moderately inclined surface, with a smooth rail, a strong rack-work is fixed upon it, which is continued beyond the summit of the incline for about the length of a train. The driving-shaft of the engine is provided with suitable pinions to gear into these racks; and the continuation of the latter will obviously enable the engine to draw the last boat of the train to the higher level. It is obvious that, by this arrangement, any amount of required fulcrum may be obtained. A line of large rollers or drums, mounted in plummer-blocks about 10 feet apart, which it is proposed to reduce to 5 feet, is fixed upon an inner and lower incline, and over these the bottoms of the boats pass, strips of stout iron being attached to them, to diminish the friction and to protect the bottoms, which are also strengthened otherwise. These rollers are continued under water in the upper and lower "pounds" of the canal, so that a support for the boats is provided the moment that the racks and pinions become engaged, and they are deprived of their natural support in the water.

The complete efficiency of this remarkably simple and ingenious mode of working a train of canal boats was amply demonstrated in the trials we witnessed at Grove, though neither in point of power nor in precision of detail is the mechanism at present to be regarded as a fair illustration of it. A small 10-horse engine, with its boiler and fuel, and subsidiary apparatus, was fitted in the leading boat, to which a train of twelve other boats was attached. These were merely old canal boats, with their sharp ends cut off square, to diminish the resistance in the water, and then cut into two smaller ones, which were laden with blocks of granite and bricks to the extent of about 100 tons. At first, the engine-boat was at the foot of the incline, and Mr. Lake ordered the train to be backed, or driven northwards along the level and smooth rails. A turn or two of the large screw sufficed to produce a good bite between the driving-wheels and the rails, and the moment the engine was set in motion the train started, and proceeded with the greatest ease of motion through the water—no eddies resulting from it, nor any undulatory effects that would be detrimental to the banks. The train threaded its way, without difficulty, through the sharp curve at the northern end of the piece, the walings guiding it continuously and gently in its assigned course. In these curves, the only preliminary precaution to be observed is, to give a little divergency to the walings to the point of maximum curvature, and then to contract them gradually for the remainder of the curve, until their normal gage is attained at the next straight piece. In going round a curve thus formed, a train of ordinary length will move freely, without risk of being jammed between the walings. In this trial, the readiness with which a train can be backed, even through a sharp curve, was clearly proved.

The engine was now reversed, and the train drawn forward in the usual manner. Its speed was here considerably above four miles per hour, and was then lessened, to show the control which the engine-driver had over it; and the levers were released until the wheels slipped upon the rails, and the train proceeded with the momentum it had acquired to the foot of the incline. There eight of the boats were detached; as the small engine at present in use is not of sufficient power to draw up more than a gross load of about fifty tons. The levers were again screwed down, and the engine set in motion, upon which the pinions geared into the racks, and the engine-boat rose gradually out of the water, commencing its ascent of the incline. As it continued to ascend, it rolled smoothly over the rollers below, and was followed by the four boats attached to it; all of which were landed, without the delay of a moment, in the upper pound of the canal. From this point the train proceeded along the remainder of its course in the upper level of the canal, and being brought back again to the incline, was allowed to descend it. The descent was accomplished with perfect ease, and the absence of all danger. All that the engineer had to do now, was to admit the steam into the cylinder on the other side of the piston, so as to render it effective in checking the motion, which would otherwise give to the mass a destructive momentum. Thus, the same engine which propels the train of boats along the level portions of the canal, by the arrangements here adopted, is also available for elevating from one level to another; a feat never before accomplished—or shown only in detail—except by means of stationary power.

The advantages of this arrangement over the present canal system scarcely require to be pointed out. Any rational alteration in the extremely inartificial and unphilosophical application of power we now witness on our canals, cannot fail to be productive of advantage; but it is evident, too, that the train system must be the basis of every approximation to economical working. Past experience, and, indeed, the remonstrances of common sense, declares against the adoption of paddle-wheels, or screw propellers, either in a train of canal boats, or in single ones; as the confined nature of the channel prevents the access of new water to the moving surfaces, and little better than a churning action is the result. We are therefore driven to substitute for the extremely imperfect reaction against canal water, that against fixed and rigid objects in the vicinity of the boats. This being so, it appears to us that Mr. Lake's system of canal steam navigation embraces all the requirements of the case, and has combined in itself all the favorable circumstances that can be brought to its aid. Having given evidence of its efficiency, a few comparisons will prove its great economy.

First, as regards construction—premising here that existing canals can be altered without any stoppage of the navigation, and the locks and other works, if it should be deemed desirable, may be left freely open for the present clumsy method of hauling. A line of level railway can be laid down on this principle at a prime cost of £1200 to £1500 per mile, according as the wood employed is oak, fir, or beech. An inclined plane of average length would cost £1000, which would be an economical substitution for the expensive works of a lock. A flight of locks might be replaced by a sufficiently long incline; and thus, upon the whole, places where locks must otherwise be constructed would become the cheapest portion of the entire work, as the inclines might be built upon land with but little excavation. The outlay incurred by laying down the works for an up and a down line of rails, would be far more than returned in a short time by the saving that would arise in the maintenance of the canal. Besides dispensing with the locks themselves, the heavy expense of lockage-water would be altogether removed; there would also be no charge for lock-keepers, no towing-paths to keep in repair, and all necessity for pumping water would at once disappear. But the greatest economy of all would arise in the cost of haulage. Every canal boat requires at least a staff of three men constantly present, and fresh for duty—one to drive the horse, another to steer the boat, and a third to run forward to get the locks ready. Of course, a larger number of persons, and four at the least must be on board, to enable certain of their number to rest when necessary. These men, besides the cost of a fresh horse at every twenty miles, must be kept in pay for each boat, which, on an average, conveys only fifteen tons of cargo. Now, under Mr. Lake's system, three men only would be necessary for a whole train of boats, as no steerers are necessary; and with a thirty-horse engine, which Mr. Lake proposes to use in practice, the train might be of almost indefinite length. The resistance of the water to a canal boat, moving at its usual speed, is about six times smaller than that of the resistance to a goods' train moving on a railway at a speed of twenty miles an hour—at which rate it is essential to carry goods on a railway, to keep the road clear for the passenger trains—and a ten-horse engine is sufficient to draw 1000 tons on a level line of canal, at a speed of three miles an hour. As for the inclines, when once the engine has passed their summit with a train occupying the whole length of the incline, it matters little how many boats are on the level below, for they are then certain of being raised. Upon the whole, the greatest gross load which could be on the inclined plane at any one time could not exceed 120 tons, and the present engine of ten-horse power takes over a gross load of fifty tons. Making the most liberal allowance for every detail of expenditure, the calculation gives from *7d.* to *8d.* per mile as the cost of carrying 300 tons on Mr. Lake's system—an immense advantage as compared with the existing one, which is at least ten times greater, and even with railway transit.

Such are the merits of this admirable invention. It needs not much penetration to perceive that it incloses the germ of a new and gigantic system of internal conveyance of merchandise, by which a new impetus will be given to our home trade. By its adoption, the canal interest of this country may once more be restored to its former magnitude and importance, and raise its head from beneath the oppressive load of railway ascendency. This much seems certain, indeed, that our goods' traffic can be more cheaply conducted in this way than by rail; and that, setting aside all considerations of rivalry, canal proprietors should have the enterprise to look forward to this invention as a means—and apparently the only means—of increasing their profits. They have been brought down entirely by mechanical means, and it is only by mechanical means, scientifically applied, that they can hope to be restored. We are glad to find that many of their number are perfectly satisfied with it on the score of efficiency, economy, and public convenience; and under all the circumstances, we eagerly expect the realization of this great scheme, as promising for the public good, as in a mechanical point of view it is simple and beautiful.—*London Mechanic's Magazine.*

M'Connell's Express Locomotive on the London and Northwestern Railway.

The directors of the London and Northwestern Railway lately announced their determination to run express passenger trains between London and Birmingham, a distance of 112 miles, in two hours; and the question of the accomplishment of this high rate of regular travelling has therefore occasioned much anxious consideration amongst the engineering authorities of the line. There were many requirements to be kept in view. Great and long-sustained power and speed, and steady running, without excessive weight, must all enter into the arrangement of the locomotives from which so much is expected. Mr. M'Connell has therefore expended more than ordinary care in designing engines which should be capable of performances hitherto quite unparalleled in the history of "the new art of transport." The fire-box has been put forward 4 feet 9 inches into the barrel of the boiler, forming what may be termed a combustion chamber. This has enabled him to obtain no fewer than 260 superficial feet of heating surface in the fire-box. For the purpose of producing as nearly as possible perfect combustion, a number of the stays connecting the combustion chamber with the shell of the boiler are tubular, and the air being drawn through them, impinges upon the flames. This produces a perfect mixture of the gases, and necessarily the largest amount of serviceable caloric is evolved. The steam-pipe presents a broad flat surface to the heated air, as it passes from the tubes into the smoke-box, so that the steam is in a manner dried as it passes into the cylinder. The stays to this form of steam pipe are tubular, and the heat from the boiler passes through them, and assists in "drying" the steam before its effective force is given to the pistons.

Ten of these engines have been ordered for completion before the end of the year; of which, two—one by Messrs. Fairbairn, the other by Messrs. E. B. Wilson & Co., of Leeds—have been already built and tried, at a rate of sixty miles per hour, with unequivocal success; and the rest will shortly be set to work, to keep up the intended systematic two hours' communications. As the best explanation of the peculiarities of the engine, we here furnish the official specification of materials, construction, and dimensions of the passenger engines:

1st.—The *Engines* to be ten in number.

2d.—They are to be made with inside cylinders, outside and inside frames, and six wheels; the driving wheel being seven feet six inches diameter, and arranged in the manner hereinafter described.

3d.—The *Cylinders* to be eighteen inches diameter, and the length of stroke two feet, fitted up with pistons made of wrought-iron or steel, to be made by Mr. Goodfellow of Manchester. The cylinders to be of the hardest and best iron, and to be free from all defects; to be bored perfectly parallel, and true when fitted. The cylinder faces to be made accurately to the drawing; also the ports and passages and the faces to be scraped to a perfect surface for the valves.

4th.—The *Boilers* to be eleven feet nine inches long in the cylinder, and four feet three and a quarter inches external diameter, and to be made perfectly circular and straight. The plates, angle-iron, and rivets to be of the best Lowmoor or Bowling iron, or of equal quality, with the maker's name stamped in a legible manner on each plate. The rivets to be three-fourths of an inch diameter; and to be one and three quarter inches apart, from centre to centre of rivet. The plates for the cylindrical part of boiler to be three-eighths of an inch in thickness; and those for the outer shell of fire-box to be of Lowmoor or Bowling iron, or of equal quality, three-eighths of an inch in thickness; and the tube-plates of the smoke-box end also to be of Lowmoor or Bowling iron, or of equal quality; to be three-fourths of an inch thick. The plates of the smoke-boxes and smoke-box door to be of the best Staffordshire iron, five-sixteenths of an inch in thickness. The chimneys to be made also of Staffordshire iron, one quarter of an inch in thickness; and the whole of the parts of the boilers and smoke-boxes to be made and fitted up in the manner shown in the drawings, which will be supplied.

5th.—The *Fire-boxes* to be made as shown in drawing, and introduced as shown in the cylinder part of the boiler, four feet nine inches; to be made of the best copper plate, free from all defects when worked. The tube-plate to be three-fourths of an inch in thickness, where the tubes are fixed. The sides and end-plates to be three-eighths of an inch thick, and the roof-plates to be seven-sixteenths of an inch thick. The bottom plates to be one-half inch thick. The boxes to be made with a middle partition in them; the plates of these partitions to be of copper, made three-eighths of an inch in thickness, and formed as shown in drawing.

The following are the leading inside dimensions of the fire-box:—Length on fire-bar to be five feet ten inches and one quarter. The length at roof to be ten feet six inches. Depth above fire-bars at front plate six feet five inches. Depth at door-plate, six feet ten inches. Width on fire-bar, four feet. Length in cylinder of boiler, four feet nine inches. Height at narrowest part, two feet three inches. Height at tube-plate, three feet. Width at tube-plate, three feet nine inches.

The top of the box to be supported by twenty-five wrought-iron bearers, twenty of which to be five inches deep by one inch thick, and the five nearest tube-plates five inches deep, by one and a half inches thick. These bearers to rest at their ends on the side-plates of the fire-box; and to be screwed to the top plate by bolts one inch diameter, placed four and a half inches from centre to centre, screwed into the top plate. The screw to be of fine thread, next head of bolt, to be one inch and an eighth diameter; the head of the bolt to be inside the fire-box, and a nut on the end of the bolts on the top of the bearers, with one-inch screw.

The *Fire-box* to be stayed to the boiler by copper bolts, seven-eighths of an inch diameter, screwed into the plates with a fine-threaded screw, having both ends riveted carefully, and placed four inches apart, from centre to centre. This also applies to the mid partition.

The end plates above the fire-box to be stayed to the smoke-box tube plate, by connecting them together by two stay bolts, each one inch and a quarter diameter.

6th.—The *Tubes* to be of brass, and made of the very best quality, by the manufacturer who supplies the Company at present; or of other equal quality, and to the approval of the Company's engineer. There will be three hundred and three tubes in each engine; the size, one and three quarter inches outside diameter, to section furnished; and the thickness of metal to be No. 12 wire-gage at fire-box end, and No. 14 wire-gage at smoke-box end.

7th.—The *Wheels* are to be made entirely of the best scrap wrought-iron, and of the very best workmanship. The driving-wheel, without the tire, to be seven feet one and a half inches diameter. The tires to be of the best Lowmoor, Bowling, or of equal quality; to be finished five and a quarter inches wide, and two and a quarter inches thick on the tread. The sizes of the wheel in all its parts will be furnished by the Company's locomotive engineer at Wolverton.

8th.—The *Crank Axles* to be made of the very best iron from the Lowmoor, Bowling, or the Haigh foundry forges, or of other equal quality, complete and perfect to the sizes given, when finished. A full-size drawing of the crank-axle in its parts will be supplied. The outside bearings to be seven inches diameter, and ten inches in length. The inside bearings seven inches diameter, and four and a quarter inches in length. The crank bearings to be seven inches diameter, and four inches in length.

9th.—The *Straight Axles* to be tubular, as shown in the drawing, of best quality of iron, seven and a quarter inches external diameter, and one and a half inches thick of metal. The bearings of the leading and trailing axles to be the same size as the crank; viz., seven inches diameter by ten inches long.

10th.—The *Axle Boxes* and brass bearings to be made according to the drawing which will be supplied.

11th.—The *Springs*, links, and attachments to the axle-boxes, to be supplied by the Company, and applied according to the instructions of their engineer at Wolverton.

12th.—The *Pumps* to be made of tough brass to the drawing furnished. The clacks and boxes to be accurately finished and fitted. The pump-rams to be made of strong tough brass, with wrought-iron cross-heads, as per drawing.

13th.—The *Steam Pipes*, blast and feed pipes, to be made of the best copper, three-sixteenths of an inch thick, with copper flanges, as per drawings to be supplied.

14th.—*Regulator* to be made of brass, on the equilibrium principle, as per drawing.

15th.—The *Eccentric Straps* to be made of the best wrought-iron, lined with gun metal of the best quality, according to drawing, accurately fitted, and to have all the oil siphons forged on.

16th.—The *Slide Valves* to be made of gun metal, and to have an outside lap of one and a quarter inch. They are to have an oil or grease cup attached on each side of the smoke-box, to lubricate them.

17th.—The *Connecting-rods* to be made of the very best quality of wrought-iron, fitted accurately. The straps to be made as per drawing, and the oil siphons to be forged on them.

18th.—The *Expansion Geer* to be made as per drawing, all the working and wearing joints and surfaces to be steeled and hardened, or case-hardened. The distance from the centres of the leading wheel axle to the centres of the middle axle to be exactly eight feet four inches, and from the centre of the middle to the centre of the trailing axle, eight feet six inches.

19th.—These *Engines* are to be manufactured of the very best materials and workmanship throughout, and supplied in every respect with water-gages, steam taps for heating water in tender, whistle, blow-off cocks, cylinder-cocks, pet-cocks, reversing and expansion geer worked from the foot-plate; screw draw-bars (proper and in duplicate), ash-pan, damper, sand-boxes, a full set of tools, lamp-irons, &c.

Detailed drawings of all the parts will be supplied by the Company's engineer at Wolverton, previous to manufacture.

20th.—The *Safety Valves* to be two in number, and to have Salter's balance applied; each valve to be three and a half inches diameter, and the levers to be of such length, that one pound upon the end of the lever shall indicate exactly one pound upon each square inch of the valve.

The range of the spring balance to be graduated up to one hundred and fifty pounds.

All the steam-joints to be fitted together by scraping, so as to be iron to iron when the joint is made; and the bolts to be placed not more than three inches apart from centre to centre of bolt.

21st.—The *Cylinder* and *Valve-chest Covers* to be of wrought-iron, to drawings furnished.

The *Fire-frame* to be made in two parts, with a drop apparatus, to drawings.

These engines to have brass domes over the steam-pipe and safety-valve, of the best yellow sheet-brass; finished and fitted in the best manner, to drawings to be supplied.

The engines and tenders to have four distinct coats of the best paint, to be finished to a specimen color furnished by the Company's engineer. Between each coat of paint, to be rubbed down with ground pumice-stone to a level smooth surface, and all imperfections removed: to be lined and finished as required, and to receive four distinct coats of the best carriage varnish, and properly hardened between each coat.

All the axles, bolts, pins, screws, and parts of machinery of these engines, to be made exactly to gages, determined by Mr. M'Connell, so that they may be perfect duplicates of each other throughout; and the Company's engineer at Wolverton, or his assistant, shall at all times, when they think proper, visit the work while in progress, to see that the materials and construction are quite according to specification and drawing. Any alteration in the minor details of this specification to be adopted, if considered advisable by Mr. M'Connell.

TENDERS.

The *Frames* are to be entirely of wrought-iron, the framing to be made of the form and dimensions as shown in the drawing; the plates being of the best Staffordshire iron, fitted up in the best manner. The side tank plates to be also of Staffordshire iron, three-sixteenths of an inch thick, with strong angle-irons as shown, and framed with flat plates outside; the floor and top plates throughout are to be one quarter of an inch thick.

The *Wheels* to be three feet nine inches diameter, to be six in number, and to be made entirely of wrought-iron, of the very best quality and workmanship. The tires of the wheels to be of the best Lowmoor, Bowling, or patent shaft iron, or of equal quality, to be approved by the Company's engineer, finished to two inches and a quarter thick on the tread.

Drawings of the wheels, with axles and axle-boxes, in detail, will be supplied.

The *Axles* to be tubular as per drawing, of quality of iron approved by the Company's engineer.

The *Springs*, as in the case of the engines, to be supplied by the Company, and applied according to the engineer's instructions.

The apparatus of the *Break* will be according to drawing, and a break is to be applied to each wheel.

The *Tenders* are to be capable of containing two thousand gallons of water, and two tons of coke, and to have spring-buffers on each end; to be supplied by the Company, and fixed according to the instructions of their engineer.

The *Draw-rod* of the tender will go through from one buffer-spring to the other. The floor of tender and foot-plate of engine to be exactly a level when properly loaded and road-worthy; with a joint flap-plate fixed to the tender, to overlay between the engine and tender.

The above particulars, with the accompanying drawings, are considered sufficient to enable the manufacturers to make their estimates. If any further information be required, the Company's locomotive engineer, at Wolverton, will afford it on application.

The engines and tenders are to be subjected to the examination and approval of the company's locomotive engineer; and are to be delivered when completed, free of charge, upon the London and North-western Line of Railway.

Our readers will thus see that the new locomotive embodies a great variety of novelties. The extension of the fire-box into the barrel of the boiler in conjunction with short tubes; tubular fire-box stays for the air supply; the lowering of the centre of gravity by recessing the under side of the boiler; dished wrought-iron pistons; and Mr. Coleman's india-rubber buffers and bearing springs; are all modifications of existing practice, which will now be thoroughly tested. The superiority of the plan of trusting to direct radiant heat rather than to carried heat, or currents on the tube surface, has been already manifested; for forty-five minutes now suffices to raise steam of 100 lbs. in the boiler, where formerly three hours were required.

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How Marine Engines should be Contracted for.[*]

The reply frequently given to those who inquire of shipowners whether they economize the fuel by working expansively, and thus develop the maximum amount of power which can be elicited from the fuel that is consumed, is not uncommonly as follows, viz.—"That they cannot afford to go *slow*. We must," they say, "keep up our pace, in order to meet the competition that is elbowing us in every direction." Under this answer (which may very possibly be correct as to their engines) is often concealed the fact that the engines and boilers were never made to realize *any* normal speed in an economical manner; and this arises, I believe, from the nature of the contract entered into between the company and the engine-maker. The former decide in conclave, that their engines shall be of a certain *nominal horse-power*, similar, perhaps, to some other line of steamers, and the engine is finally paid for at the rate of so many pounds sterling per nominal horse-power. But the nominal horse-power of an engine has for a long time ceased to afford any sufficient criterion of its real power; and the continued use of it, as the criterion when estimating and paying for the real power that is exerted, tends, I believe, to foster the practice of giving the cylinders such dimensions, and the steam such a pressure, that it is impossible to elicit the required speed with the greatest economy of fuel per mile.

It may be as well to enter more at large into this subject. The *real horse-power* of an engine is measured by the mean effective pressure in lbs. per square inch (deducting sometimes about 1·5 lb. for friction, &c.) exerted on each square inch of the piston; the number of square inches on the surface of the piston on which the pressure acts; and the speed in feet per minute at which the piston moves. The product of these three quantities divided by 33,000, is called the *real horse-power* of the engine. This of course will vary in amount with all the circumstances that can affect the variables, such as the resistance, trim, &c. In calculating the *nominal* horse-power, the number 7 is substituted for the mean effective pressure, and is therefore a constant. For the velocity is substituted a certain stated velocity, which engines of certain strokes are expected to make good.[*] The area of the cylinder being the third factor, depends, of course, for any given horse-power that may be required, on the velocity that is expected. The area of the cylinder per nominal horse-power may therefore be considered as a constant also for the same nominal horse-power. It varies inversely with the velocity, and therefore with the nominal horse-power, decreasing from about thirty square inches to twenty square inches per horse-power, so that giving an order for an engine of a given horse-power, is, in other words, ordering a pair of cylinders of a given diameter and a given stroke. These factors were decided on by Watt sixty years since, when seven pounds per square inch was really a fair representation of the mean effective pressure developed by the engines of that day, when the mechanism of the engine, the packing, &c., were so imperfect, that it was impossible to use strong steam; and when the steam was of so low a pressure, that it was not considered convenient to give the cylinders such a size as to enable the steam to be expanded down to its lowest useful pressure. But the *economy* of working high-pressured steam expansively is at length generally admitted; and the improvements in the mechanism of the engine, combined with the fact that the public will now tolerate the use of moderately high-pressured steam, point out that the continuing to admit the anomalous term *nominal horse-power*, with its obsolete factors, to be the guide of contracts for engines, and to present, as it does, a formidable obstacle to the provision of *economical* engines, is, to say the least, most suicidal on the part of the directors of steam-packet companies.

It would not be fair to a contractor to attach any blame to him in this matter; for, though he may be well aware that ultimate economy to the company would be the result of enabling the required normal speed to be elicited by steam that has been expanded down to its lowest useful limit, yet he has learnt that while the formula for calculating the nominal horse-power remains, as that by which he is to be paid, he could not, except at a loss to himself, so make the engine as to elicit the above-named economy; for if, by any artifice, it was made the contractor's interest to supply an economical *working* engine, he would do it in either of the three following ways:

1. By using high-pressured steam, and cutting it off earlier in the same sized cylinder, or

2. By using still higher-pressured steam, and cutting it off earlier in a smaller cylinder, or

3. By retaining the same pressure, but cutting the steam off earlier in a larger cylinder.

But under the present system of payment, if he attempted to gain the end of making an economical engine by the first plan, he would have to supply a stronger, and therefore more expensive boiler than that which the competing contractors would supply, which would raise his estimated cost per horse-power above theirs; or if he lowered his estimate to the same amount as theirs, he would receive no consideration for the additional strength of the boiler.

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[*] From Ryder's treatise on Economy of Fuel.

[*] In screw vessels, a much higher speed is expected from the piston than is due to the same length of the stroke in a paddle-wheel vessel, and its amount is therefore a matter of stipulation between the steam-packet company and the engine-maker.

Again, if he attempted to supply an economical *working* engine by the second plan, he would find that, in addition to the previous cause of loss (viz., the additional strength of the boiler), the area of the small cylinder would be introduced as the factor in calculating the cost of his engine; and that if, anticipating this, he raised his estimate per nominal horse-power, his competing contractors would, without difficulty, under-estimate him.

Again, if he attempted to supply an economical working engine by the third plan, the additional expense of the large cylinder would either have to be defrayed by himself, or the competing contractors would underbid him in their estimate for the total cost of the engine.

This, then, is the state of the case between those who order engines and those who contract to make them. The latter have at present no interest in supplying an engine that will work economically in the matter of fuel per mile; for they know that, in however small a degree they may attempt to do so by increasing the pressure of the steam, or altering the size of the cylinders, they would always find that they were exposed to a loss of money if they attempted to compete with the other contractors in their estimate per nominal horse-power, or a loss of the contract if they tendered so as to give themselves a fair remunerating profit.

To remedy this evil, I would propose to substitute some other formula for that which is now in use. I suggest the following formula, more with a view to induce some one else to improve upon it, than with any hope that it will, in exactly its present shape, be established as sufficient for the purposes for which it has been designed.

To illustrate the manner in which the proposed formula would be used, I will suppose the case of a steam-packet company whose directors have decided on opening a contract for engines for a new line of packets. They will first obtain lines, dimensions, &c., from their builder, and then appoint a superintending engineer,[*] whose duty it will be to draw up the contract, watch its fulfilment, and attend at the consultations between the builder and the engine-maker, who should be brought together as soon as possible. The specification would include the following points:

Engines to be tendered for by selected engine-makers of established reputation (of course no tender would be accepted, however low, except from men of this class).

Direct-action engines to be placed in a ship that will be trimmed at her trial draught to —— feet aft, and —— feet forward, and whose midship section will be at her trial —— square feet (to be verified before launching), and of whose lines and dimensions a copy is inclosed:

The speed[†] at the measured knot is to be at least, ... } —— knots.

Diameter of wheels to be decided on between builder and engine-maker.

Immersion of upper edge of floats at trial trip to be . . . . . . } —— feet.

Load on safety-valve not to exceed . —— lbs. per. sq. in.

Weight of engine and boilers, with water, not to exceed . . . . . } —— tons.

Cubical contents of space occupied . . —— cub. feet.

Note.—If the weight of the engines, &c., that are supplied, is less than the above, the vessel will not be required to be brought down to the first-mentioned trial draught, but to a draught lighter by a number of inches, due to the decreased weight of machinery.

Payments to be made by means of the following formula:

$$\text{£ sterling} = \frac{\left\{\begin{matrix}\text{Speed at measured knots}\\ \text{not exceeding } a \text{ knots}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Length of stroke}\\ \text{not exceeding } b \text{ feet}\end{matrix}\right\} \times \text{A}}{\text{Portion of stroke passed over before the steam is cut off not less than than } c \text{ feet.}^{*}}$$

All engine-makers who send in tenders, to forward at the same time drawings, dimensions, weights, and the figures that they are prepared to substitute for the factors A, *b*, and *c*.

There is, of course, a relation between the area of the cylinder and the strength and weight of the machinery; but this formula leaves it open to the ingenuity of the engine-maker to proportion the weight of the boilers and engines in such a way as shall be most remunerative to himself.

It also gives him a direct interest in realizing the highest speed and the best vacuum (because the better the vacuum the less need the positive pressure or area of cylinder be), and also the maximum amount of useful expansion, because the numerator of the fraction is thereby increased. The company would thus insure that the economy of fuel per mile (if the boiler is well constructed)[†] shall be a maximum also.

It will, of course, be necessary to establish by experiment that the amount of expansion proposed to be given shall not embarrass the engine in turning its centres in moderately heavy weather, or affect seriously the equability of the motion; obstacles to the thorough carrying out of the principle of expansion which prevent the single engines in some of the steamers in the United States from being worked as expansively as would otherwise be the case.

The company would, of course, reserve to itself the power of enforcing forfeits for a non-fulfilment of engagement; as, for instance, £—— a ton for overweight; £—— for every tenth of a knot less than the required speed, in addition to the loss from the formula. The engine-maker who gave the lowest estimate for A would, *cæteris paribus*, be selected.

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Wright & Hyatt's Elliptic Rotary Engine.

THE "elliptic rotary engine" is one of the most successful examples of the modern attempts to apply steam power directly to a revolving crank lever, so as to economize steam, lessen the weight, simplify the constructive details, and convey the power directly to its work. Such an engine is, indeed, practically equivalent to the causing the steam to lay hold of and actuate the crank or revolving shaft, just as the hand turns round a winch, without the intervention of joints, levers, and connecting-rods. It is the invention of Mr. William Hyatt, the engineer to Champion's extensive Vinegar Works, of Old Street Road, St. Luke's, London, and is being carried out by him, in conjunction with Mr. Wright, the managing proprietor of the works. The essential peculiarity of the engine is to be found in the fact, that the steam cylinder is bored elliptically, in order that the revolving piston within it, when set upon a shaft disposed eccentrically in relation to the minor axis of the ellipse, may fit accurately to the elliptic surface throughout the entire revolution. This is a peculiar and unlooked-for characteristic of the elliptical figure. The true action is only to be secured when the amount of ellipticity is exceedingly slight, the centre of motion of the revolving piston-shaft being in a line intersecting the minor axis, at about one-third the length of such axis. That such an engine does work in the most satisfactory manner, is now practically exemplified at the Old Street Vinegar Works, where the engine, from which our drawings were made, is in daily operation.

Fig. 1 is an external longitudinal elevation of the engine in working order. Fig. 2 is a corresponding end elevation, at right angles to Fig. 1, the front end cover of the cylinder being removed to show the piston within.

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[*] There is an unfortunate, but apparently a necessary, result of having a superintending engineer—viz., that after having approved of the design and tender of an engine-maker, he is tempted, to a certain extent, in order to justify his selection, to overlook any fundamental defect that may appear on the experimental trials. He is likely to feel that his own professional reputation depends on the success of the engines; and although he will take very good care that all defects of a slight and removable nature are remedied, yet, if any radical error shows itself, which he ought to have discovered in the designs, he is, as I have already said, exposed to the very serious temptation of overlooking or ignoring it.

This is a necessary evil, and its existence does not militate against the propriety of all large companies having a superintending engineer, whose qualifications will of course depend on the income that is provided for him.

Mr. Atherton, in p. 7 of his work on *Marine Engine Classification*, says, that the approval of a superintending engineer has been invariably found to limit the responsibility of the contractor to the effective execution of the specified and approved work which he has undertaken to perform.

[†] It will be necessary, in deciding on the speed for the new line of steamers, if there is already a line with which competition is intended to take place, to obtain all possible information about the speed (average) made good by the existing line, the weather at the different periods of the year, also a set of diagrams under the different circumstances of prevalent gales, currents, &c., against which the steamers have had to contend, from which the real power that has been required can be calculated. These, together with the dimensions and *midship sections* of the existing line of steamers, will prove highly useful towards insuring the success of the competition, and determining whether it shall be made to depend on the same speed being elicited more economically, or whether a higher speed shall be attained.

[*] In sending out for tenders to construct engines for *steamers-of-war*, as the maximum speed would have to be obtained when a considerable portion of the stroke was passed over, the denominator as given above would insure that important point being properly attended to, thus leaving sufficient room for economical cams.

[†] To insure the boiler being well constructed, a fire should be lighted in it before it is hoisted in, and the quantity of water evaporated per lb. of coal carefully measured by an experiment, say of twenty-four hours' duration: the usual quantity of water evaporated per lb. of coal should be insisted on before the boiler is hoisted in. This experiment will also inform the superintending engineer whether the boilers are sufficient to supply the requisite quantity of steam.

Fig. 1.

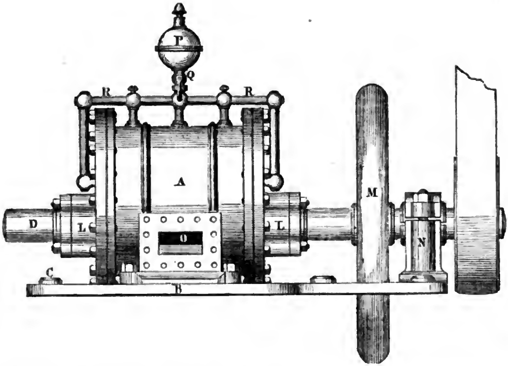
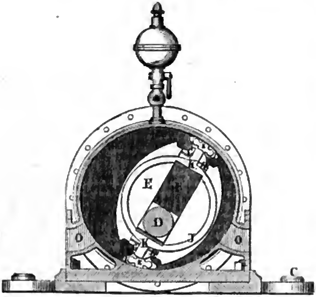


Fig. 2.



The short steam cylinder A, open at each end, and fitted with two end covers, is placed with its axis horizontal upon the base plate B, being bolted down thereon by four projecting eyes C. The horizontal piston-rod, or main engine-shaft D is passed eccentrically through the cylinder, and in the vertical line of the minor or conjugate axis of the ellipse. The cast-iron rotatory piston E is suitably fitted with packing-pieces, and slotted transversely at F to fit to the piston-rod, the transverse section of which at that part is rectangular. The slot F is for the purpose of allowing of the self-adjustment of the piston during its revolution in working, by sliding laterally over the squared shaft or rod D; or, instead of this more direct sliding action, a frame may be introduced to carry anti-friction rollers, working upon the shaft surface, and adjustable by the aid of screws and wedges. The packing of the piston—which packing is, at the same time, a portion of the working steam-pressure surface—consists of two metallic strips or ribs G, of the length of the cylinder, the outer projecting surface of such ribs being rounded, whilst their inner flat sides are fitted into shallow grooves H, formed diametrically opposite to each other along the piston, and in its axial line. The actual working packings are strips of metal I, fitted on their inner sides to the external rounded surfaces of the pieces G, whilst their outer surfaces bear against the interior of the cylinder. These outer rubbing surfaces of the packings I are considerably rounded in transverse section, the radius of curvature being slightly less than that of the quickest curve of the cylinder's bore, so that the packing may work round the sharpest elliptic curves with facility, and helical springs are set in behind the packing-pieces to admit of a free adjustment during working. The flat end packing for keeping the piston steam-tight at its two ends, is composed, in each case, of the brass ring J let into the end of the piston, and having two projections K upon it, passing through slots in the end of the strips G, thus forming a simple and effective end packing. A small brass plate K′ is let into the end of the strips I to complete the end packing. The piston-rod is supported in a stuffing-box L, on the outside of each cylinder end cover, and the engine in the present case being a single one, the shaft has a fly-wheel M keyed upon it, the heavy rim of the wheel being cast hollow at certain parts to balance the overhang of the piston. That end of the shaft which passes away to the machinery to be driven is supported in a pedestal N, bolted down on the base plate; this bearing, in conjunction with the pair of stuffing-boxes, being the only bearings requisite. When one end only of the shaft is used for driving, no working valves are required in this engine, the steam being admitted in a constant stream by either of the two opposite ports O, the only variation of the current being when the slot F is horizontal, this being the dead centre of the engine, and both ports are then closed. Or, by another slight modification, the steam and exhaust ports may be made to extend a long way round the cylinder, in order that the engine may have no dead point, the steam being admitted to the back of the revolving piston-blade before it is entirely shut off from the front side. For reversing, an ordinary three-way cock answers every purpose, one cock being set on each side of the cylinder, and put in connection by means of two double-branched pipes, so that either side may be made the steam ingress side. The steam acts equally well in both directions of revolution, the effective pressure being that upon the overhang, or eccentricity of the piston, which is constantly varying in effective area throughout the revolution, the piston being indeed a direct-acting crank-lever for turning the shaft. For lubrication, an oil-reservoir P is set on the top of the cylinder, a stop-cock Q being fitted beneath it, to command the flow through the pipes R, which have each two branches for lubricating the bared portion of the cylinder and the flat end cover surfaces. The length of the axial line of the cylinder of the engine in our plate is 24 inches, whilst its diameter or bore is to be defined by an ellipse with a major axis of 20¾ inches, and a minor axis of 18¾ inches. This engine is called a 30-horse, whilst with a pressure of 32 lbs. of steam, the indicator has shown a power of 50 horses. Our readers may judge of its compactness by comparing this power with the area actually occupied, as shown in our drawing.

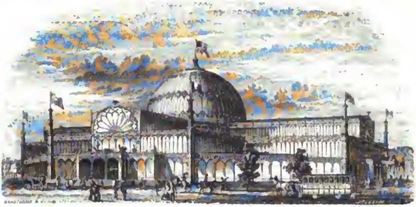
We think we may safely point to Mr. Hyatt's engine as being the simplest and most compact of the really effective existing examples of the direct-pressure rotatory class. It is evidently applicable for all the purposes to which the ordinary engine can be applied, as well as to many which are beyond the reach of the old form. With an actuating power applied to its shaft, it at once becomes a forcing or exhausting pump; and, slightly modified, it becomes suitable for the purposes of locomotion. As a railway engine, it is proposed to use two cylinders—one on each driving axle—the axles being thus made the engine piston-rods, whilst the dead points are of course avoided by the usual expedient of setting the lines of greatest effect at right angles to each other, the axles being coupled in the common way.

But the most obvious application of the engine is for screw propulsion. The screw-shaft becomes the piston-rod, and as there is no reciprocation about it, any reasonable speed is attainable, whilst the power is conveyed direct to the screw. Indeed, the practical value of this motor is, in our opinion, as great as its peculiar mechanical action is elegant.—*Glas. Prac. Mech.*

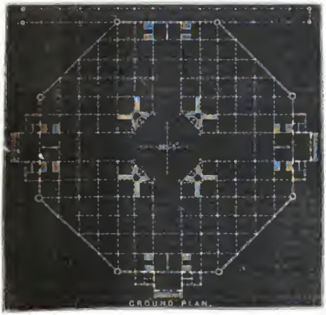
Elevation and Plans of the New York Crystal Palace.

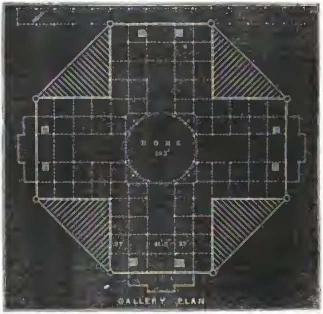
This building, of which the second story is now being raised, is located on Reservoir Square, a rough lot adjoining the distributing reservoir of the Croton Aqueduct, and about two miles above the heart of the city.

The details of the construction generally correspond with those of its great prototype of 1851, in London. Some peculiarities, interesting in a professional point of view, have been introduced in the dome, to which we propose again to refer. The whole construction is entirely of iron and glass, with the exception of the floors. Several views of the building have been published in various styles, none of which, including that given below, are strictly correct. The accompanying plans have, however, been prepared with considerable care, and are believed to be unexceptionable.



The general idea of the edifice is a Greek cross, surmounted by a dome at the intersection. Each diameter of the cross will be 365 feet 5 inches long. There will be three similar entrances, each 47 feet wide: one on the Sixth Avenue, one on Fortieth, and one on Forty-second streets. There will be sixteen flights of stairs, as represented.





The building contains on the ground-floor 111,000 square feet of space, and in its galleries, which are 54 feet wide, 62,000 square feet more, making a total area of 173,000 square feet for the purposes of exhibition. There are thus on the ground floor two acres and a half, or exactly 2$\frac{55}{100}$; in the galleries, one acre and $\frac{44}{100}$; total, within an inconsiderable fraction, four acres.

There are on the ground floor 190 octagonal cast-iron columns, 21 feet above the floor, and eight inches diameter, cast hollow, of different thicknesses, from half an inch to one inch. These columns receive the cast-iron girders; these are 26½ feet long and 3 feet high, and serve to sustain the galleries and the wrought-iron construction of the roof, as well as to brace the whole structure in every direction. The girders, as well as the second-story columns, are fastened to the columns in the first story, by connecting pieces of the same octagonal shape as the columns, 3 feet 4 inches high, having proper flanges and lugs to fasten all pieces together by bolts. The number of lower floor-girders is 252, besides 12 wrought-iron girders of the same height, and 41 feet span over a part of the nave. The second story contains 148 columns, of the same shape as those below, and 17 feet 7 inches high. These receive another tier of girders, numbering 160, for the support of the roofs of the aisles, each nave being covered by 16 cast-iron semicircular arches, each composed of 4 pieces. The long parallelogram, dotted across the rear of the building, indicates the arcade, as it is styled, for the accommodation of the steam-engines and power machinery generally. This will be to most of our readers the most interesting portion of the exhibition, but has been omitted in all the descriptions we have seen of the intended Fair. It will fill the space between the main building and the Reservoir inclosure, and will be 419½ feet in length, and one story high.

The building is advertised to open on the second of May. The erection is progressing under the superintendence of Mr. Detmold, C. E., the contracts having been divided among various houses. The designers and architects are Messrs. Carstensen and Gildemeister. The former gentleman was also the designer of the Tivoli and Casino of Copenhagen.

[For Appletons' Mechanics' Magazine.]

Spindle Foot-Bearings.

Mr. Editor:—I noticed in your January number an illustration of a foot-bearing recently introduced in England, and will avail myself of the invitation to correspond so cordially extended to all your subscribers on the last page of the same number.

Without criticising at any length on the suggestion there presented, I wish particularly to object to one feature of the step now in use. I allude to the custom which has long prevailed—and, so far as I am informed, still obtains—among builders of cotton and woollen machinery, of making the foot-bearings of spindles pointed at the bottom—a general form being represented in Fig. 1. The machinists assign various reasons for that particular form, the most common one being that it is the custom. I am confident, from a somewhat lengthy experience as a cotton manufacturer, that the form represented is not a correct one to insure a steady motion, or a uniform wear on the foot of the spindle. It is a fact well known, that in spindles driven by bands, the spindle has an inclination towards the cylinder, or a tendency to move to one side of the centre. This gives the spindle, when pointed as in Fig. 1, an inclination to rise, especially if the step-box is worn.

Fig. 1.

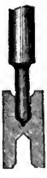


Fig. 3.

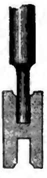


Fig. 4.

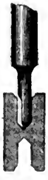


Fig. 5.

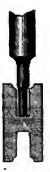
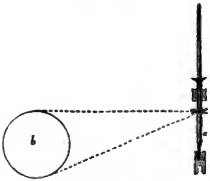


Fig. 6.

To illustrate the matter, we will suppose the spindle *a*, Fig. 2, to be in motion, and driven by the band, as represented. The spindle must have a tendency towards the cylinder *b*, which will eventually wear the points in contact and give play to the spindle, and it will at once be seen that as the step-box wears to one side, the bevel of the step-box, acting as an inclined plane, raises the spindle from its place, and as the band slackens (as it continually does in its vibrations) it settles again, thus partaking of the motion of the vibration of the band. This dancing of the spindle, increasing with the wear, tends to increase the vibrations of the band, which in its turn aggravates and increases the evil in question, producing any quantity of noise and imperfect work.

Fig. 2.



The correct form would be that now adopted by all our best-informed millwrights as a bearing for the foot of upright shafts, and other situations where there is end-strain; that is, to square up the end or bottom of the spindle, and let the step-box correspond as near as possible in form. There would certainly be less surface exposed on the bottom, and, in my opinion, it will wear evenly and to the same depth entirely around the spindle, which is not the case where the spindle is pointed or rounded. In no instance have I ever seen a heavy spindle, such as are used in our best-finished ring spinning-frames, worn evenly at the bottom. They are invariably worn as in Fig. 4, of which Fig. 6 is a cross-section—the very worst form possible for a pointed foot. The square foot, supposing the material of the spindle to be of equal hardness, would be likely to wear equally, as in Fig. 5.

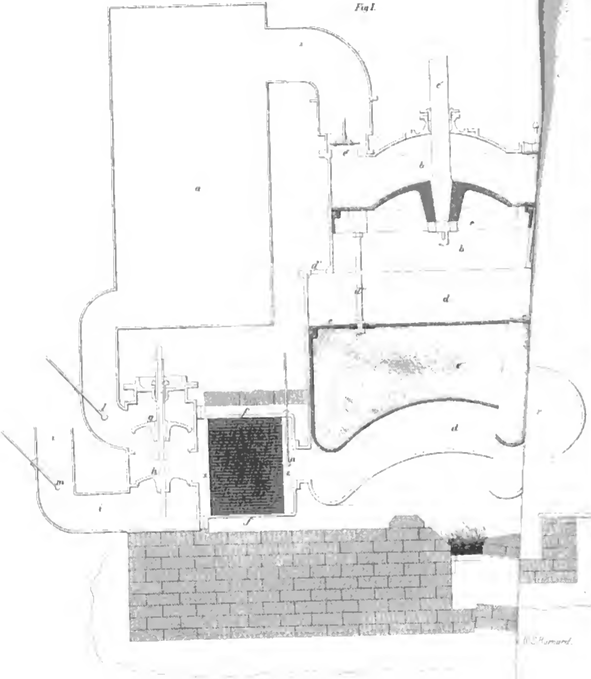
I present these ideas, not as particularly new or original, but in the hope of eliciting remarks from others more able to handle the subject.

W. H. B.

New York, January 12.

"Custom" is a very important reason for adhering to an antiquated style in the details of any machinery. The simple fact that purchasers would buy the old without question, while the new would require a long explanation, is enough to account for much of the slow progress in various departments of mechanism. Nothing tends more clearly and quickly to dispel the clouds of prejudice than a plain presentation of the subject, as above. We hardly agree, however, with W. H. B. with regard to the side-wear being caused by the jumping of the spindle or the vibration of the band, although these might aggravate the effect. We have always considered it due to the centrifugal force arising from its rotation. No spindle is or can be perfectly straight and of equal density in each portion. Revolving at a rate of from 4000 to 12,000 turns per minute, the slightest want of balance, assisted, perhaps, by the springing of the spindle to some extent when loaded with a full bobbin, enables the centrifugal force generated by its intensely rapid revolution to overcome even the draft of the band and throw all the pressure and wear on one side of the foot.

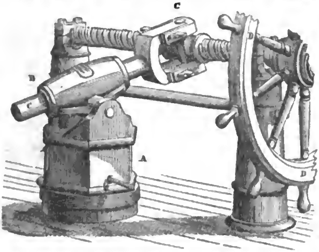
Fig. I.



W. C. Rumard.

Robinson and Green's Steering Apparatus.

We find in a foreign journal a description and engraving of a steering apparatus, which seems to combine the desirable qualities necessary in an efficient arrangement for managing the rudder. Our engraving represents all the working parts, the novelty of which consists principally in the introduction of trunnions at the rudder-head, so that the rise and fall of the rudder does not in any way strain the machine.



A is the cap of the rudder-head, on which a cast-iron socket B is hung on trunnions so as to swivel. Through this socket slides the lever C C, the upper end of which holds on a swivel the nut of the screw, moved by a steering-wheel in the ordinary manner. As one end of the lever C moves in a straight line whilst the socket describes a circle, it is obvious that a longer leverage is obtained when the helm is hard over, than when it is amidships; and thus the steersman has greater power over the helm just at the moment it is most required.

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Ericsson's Caloric Engine.—Description of the Plate.

[The following description of the plate, and explanation of the working of the caloric engine, has been kindly furnished for the *Mechanics' Magazine* by Capt. Ericsson himself. The plate is an exact working drawing of the stationary test engine, that being more available for illustration than the engines of the ship.]

a, air receiver.

b b, supply cylinder; *e′*, self-acting valve for letting air into, and *e′ e′*, self-acting valve for letting air out of the same.

c, supply piston; *c′*, piston-rod of the same, connected to the working beam of the engine.

d d, working cylinder; *d′ d′*, holes at the junction of the two cylinders, through which the atmospheric air passes in and out freely.

e e, working piston; *d″ d″*, rods connecting the two pistons together.

e‴, air-tight vessel suspended below the working piston, filled with clay and charcoal, to prevent transmission of heat from below.

f f, regenerator; *f′*, disks of wire-net placed vertically in the regenerator box.

g, valve worked by the engine for admitting air into the regenerator and working cylinder; *h*, valve for letting the air out of the same.

i i, pipe, open to the atmosphere, for carrying off the air after having passed through the engine; K, fireplace.

l m n, thermometers inserted to ascertain the temperature within.

The operation of the engine is briefly as follows: a slow fire being kept up at K for about two hours, until the various parts contained within the brick-work shall have become moderately heated, the air receiver is charged with air by means of a hand-pump; as soon as the internal pressure shall have reached about six pounds to the square inch, invariably effected in less than two minutes, the hand-pump is stopped, and the valve G opened by a starting lever, as in steam-engines; the compressed air from the receiver, thus admitted under the valve G, rushes through the partially heated wires *f′* into the working cylinder, forcing its piston *e* upwards, as also the supply piston *c*, by means of the connecting-rods *d″ d″*; the atmospheric air contained in the upper part of *b* will, by this upward movement of the supply piston, be forced through the valve *e″* into the air receiver; when the working piston has reached three-fourths of the full up-stroke, the valve *g* is closed by the engine; and when the piston has arrived at the full up-stroke, the valve *h* is opened. A free communication with the atmosphere being thereby established, by means of the open pipe *i i*, the air under the working piston passes off, and, owing to the removal of pressure under the working piston, it will instantly begin to descend by its own weight.

The heated air from under the working piston, in passing off through the wires *f′*, gives out its caloric to the same so effectually, that, on reaching the thermometer *m*, the temperature never exceeds that of the entering air at *l* by more than 30°; on the other hand, the cold air from the receiver, in circulating through the meshes of wires in its passage to the working cylinder, becomes so effectually heated that, on passing *n*, its temperature is invariably increased to upwards of 450°, when the machine is in full operation.

It is evident that during the descent of the supply piston *c*, the outlet valve *e″* remains closed by the pressure from the receiver, whilst the inlet valve *e′* is kept open by suction, and hence that a *fresh* quantity of atmospheric air enters the supply cylinder at each down stroke of its piston, and by the up-stroke is forced into the receiver. There being two supply cylinders of alternating action, a constant supply of fresh air into the receiver is obtained for feeding the working cylinders.

It need hardly be stated that the smaller quantity obtained by the supply cylinder suffices to fill the larger capacity of the working cylinder, in consequence of the increase of volume attending the increase of temperature; nor need it be stated that an equal amount of force is exerted by the up and down movement, as there are two pair of cylinders attached at opposite ends of a common working beam.

The foregoing description being deemed sufficient to explain the mechanical operation of the engine, the result of its prolonged trial may now be considered, but before doing so, it will be well to state some particulars in relation to the regenerator: the regenerator measures 26 inches in height and width internally; each disk of wire-net contains 676 superficial inches, and the net has 10 meshes to the inch; each superficial inch therefore contains 100 meshes, which, multiplied by 676, gives 67,600 meshes in each disk; 200 disks being employed, it follows that each regenerator contains 13,520,000 meshes, and, consequently, if we consider that there are as many small spaces *between* the disks as there are meshes, we shall find that the air within the regenerator is distributed in 27,000,000 of minute cells. Theory clearly indicates that, owing to the small capacity for heat of atmospheric air, that beneficial property which the Great Mechanician gave to it as a fit medium for animated *warm* beings to live in, and in consequence also of the almost infinite subdivision among the wires, the temperature of the circulating air, in passing through the regenerator of the caloric engine, must be greatly changed. Practice has fully realized all that theory predicted, for the temperatures at *x* and *z* have never varied, during the trials, less than 350° when the engine has been in full operation; indeed it has been found *impossible* to obtain a differential temperature of less magnitude, with sufficient fires in the furnaces.

The reason is evident: the *cold* air from the receiver is half the time playing upon the wire disks at *x*, whilst the *heated* air from the working cylinder is playing during the other half on the wire disks at *z*; as no heated air can reach the former without passing through the regenerator, and as no *cold* air can reach the disks at *z* before likewise passing all the wires, it follows that the establishing an equilibrium of temperature becomes impossible. The great number of disks, their isolated character, and the before-named distribution of the air in such a vast number of minute cells, readily explains the surprising fall and increase of temperature of the opposite currents passing the regenerator, and which constitutes the grand feature of the caloric engine, effecting as it does such an extraordinary saving of fuel, by rendering the *same caloric* active over and over again.

In further explanation of the wonderful efficiency of the regenerator, it may be stated that each disk contains 1140 feet of wire in length, and each regenerator 228,000 feet, or $41\frac{1}{5}$ miles of wire; the superficial measurement of which is 2014 square feet, which is equal to the entire surface of four steam-boilers forty feet long and four feet diameter; and yet the regenerator displaying that great amount of heating surface is only two feet cube, less than $\frac{1}{1078}$ of the bulk of said boilers!

In regard to *loss of heat*, the result of ample trial has been, that at no time has the temperature of the escaping air at *m* exceeded that of the entering air at *l* by more than 30°. As this differential temperature exhibits the *positive loss of heat*, it becomes important to ascertain its amount in pounds of coal: the area of the supply piston is 2626 square inches, and its stroke two feet; hence $36\frac{4}{10}$ cubic feet of atmospheric air is supplied for each stroke, and therefore at 30 strokes 1092 cubic feet, and for both cylinders 2184 cubic feet per minute = 131,040 cubic feet per hour. The weight of atmospheric air is nearly $13\frac{1}{2}$ cubic feet to the pound, and hence it will be seen that 9706 pounds of air pass through the engine every hour. We know that one pound of coal will raise the temperature of 10 pounds of water 1100°; the specific heat of water being to that of the air as 26 : 100, it will also be seen that $38\frac{4}{10}$ pounds of air will be elevated in temperature 1100° with one pound of coal; now the observed loss of heat in the engine being 30°, the fact will be established that the loss will be only one pound of coal for every 1408 pounds of air passed through the engine, which, on 9706 pounds, proves the actual loss of heat in both regenerators to be only $6\frac{8}{10}$ pounds of coal per hour; a pressure of 13 pounds being sustained in the receiver exerting 60 horse-power, with an actual waste of only 6·8 pounds per hour, it will be found that *two* ounces of coal per hour per horse-power is the quantity of fuel absolutely wasted in the process of transfer. The actual consumption of the engine is, however, nearly 40 pounds per hour, which is thus proved by the foregoing to be chiefly carried off by radiation of heat; on a large scale much of that radiation will be prevented; as the machine stands, a horse-power is produced by a consumption of less than 11 ounces to the horse-power per hour.

The following particulars are of considerable practical importance:

1st. The valves *g* and *h* are *not* subjected to heat, the caloric being taken up by the wires before reaching the valves.

2d. The temperature of the packing of the working pistons does not exceed boiling heat at any time, proving the efficacy of the heat intercepter e'''.

3d. As only a slow radiating fire is needed, it has been found that common whitewash, applied to the under side of the heater, remains for several weeks; this proves conclusively that the effect of the heat is quite harmless.

4th. A hole of half an inch in diameter, kept open for several hours in the valve chest, does not sensibly affect the pressure in the receiver *a*, so abundant is the supply of air; this fact has surprised all practical men who have seen the engine; it proves completely that the machine need not be perfectly air-tight, as supposed by many.

5th. After putting a moderate quantity of fuel into the furnace, it has been found that the engine works with full power for three hours without fresh feed, and after removing the fires entirely, it has frequently worked for one hour.

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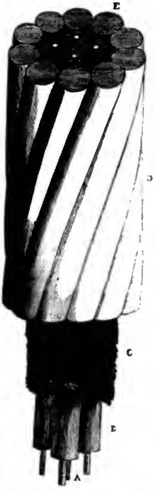
The Telegraphic Lines of the World.

[Continued from page 3.]

Submarine.—The Newfoundland Electric Telegraph Company, intended to connect the Old World and the New by the shortest possible line of steam communication, was proceeding steadily towards completion at latest accounts. Mr. Gisborne has succeeded in laying the submarine cable between Cape Tormentine, in the province of New Brunswick, and Carlton Head, Prince Edward's Island. The communication to this point was to have been complete before the close of this year. The design of this line is to take the news from Cape Race, the most eastern point in Newfoundland, and, touching at St. John's, on that island, to cross to Cape Ray, thence, in a submarine line of 140 miles under the Gulf of St. Lawrence, to Prince Edward's Island. Crossing that island, another submarine stretch of ten miles reaches the main land, from whence it is intended to connect with Boston and New York, by an independent line. This line is to be ready for use in the coming summer. It has been stated that the English system of laying down, instead of suspending, the wires is to be adopted in the eastern portion of this line.

The accompanying engraving, which we find in the London Mechanics' Magazine, represents the structure of the cable which has successfully overcome all the difficulties of submarine telegraphing during the past fourteen months or more, and through which messages have been passed from England to France, and *vice versa*, at the rate of, perhaps, four hundred per week, without a single interruption. It is stated, on the authority of the first telegraphic engineers of both countries, that no land telegraphic communication has been yet so perfectly insulated as the submarine cable from Dover to Calais. The peculiarly valuable insulating qualities of gutta percha appear to be improved, rather than impaired, by immersion in salt water.



A represents the four conducting copper wires; B, their coverings of gutta percha; the ends of the four wires, and also their double coverings of the gum, are also represented in section at E; C is spun yarn, saturated with tar, wound round the covered wires, and filling up the interstices, so as to form a core, upon which the galvanized wires are laid; D is the outer protection, consisting of ten galvanized iron wires; E, section of the cable complete.

This cable was manufactured in the short space of about three weeks, being 24 miles in length, and about 180 tons in weight. In consequence of some irregularities in laying it down, this length was found too short to cover the 21 miles between the two points, and an additional mile was made and spliced on. This telegraph is owned by the Submarine Telegraph Company.

A similar cable was made and laid down by the same firm, R. S. Newall & Co., Gateshead-on-Tyne, on their own account, between Holyhead and Dublin, which worked perfectly for several days; after which its insulation became imperfect, from what cause has not yet been published.

A cable entirely of hemp, without any galvanized wire covering, was laid down between Portpatrick and Donaghadee by the same firm, for the Magnetic Electric Telegraph Company. This has entirely failed. According to some of the papers, the skipper of some small craft having accidentally fished up the rope with his anchor, cut off 472 yards, and sailed to market with his prize—a very sufficient reason, if correct, for the defective working of this line. An account which lately appeared over the signatures of the contractors states that it was never laid complete—that it was extended to within about 7 miles of the Irish coast, and then cut, bad weather compelling them to abandon the project for the time. Communication with those on shore was obtained up to the moment of cutting the cable. The depth of water in the Irish Channel, through some of the deepest of which this line had already passed, was from 10 to 150 fathoms. The greatest depth in the Dover Straits, in which the cable, as stated above, has worked with complete success, is 35 fathoms.

The great project, however, in connection with submarine telegraphing, and, in fact, the only scheme in which it becomes of much interest in the American mind, is a direct telegraphic communication between the shores of the Old and New World. The fact, as stated in our last number, that no single circuit had been yet made sufficiently powerful to operate through more than 1500 miles of wire, seems at first to militate against the possibility of ever attaining to the realization of this stupendous undertaking.

By taking Iceland and Greenland in the route, however, the distance is so divided, that so soon as the successful working of the above-named lines shall have become fairly and fully established, this object, which the combined engineering skill of the world may well be ambitious of accomplishing, will be within our grasp. All the great preliminary steps have been reduced to something like maturity by the labors of the promoters of the Ocean Telegraph Company in Great Britain.

At present, the project assumes the following form:—The telegraph will leave the mainland of Great Britain at some convenient point on the extreme coast of the county of Caithness, and proceed thence to the Orkneys, with a station at Kirkwall. A second submarine line will extend to Shetland, where it is proposed to have a station at Lerwick. From Shetland, a long submarine telegraph will proceed to the Ferroe Islands, with a station at Shorshaven; and from Shorshaven, another submarine line will go to Reikiavik, on the southeastern coast of Iceland. A land telegraph will carry the line through the interior of this large island to the opposite promontory of Sneefelds; and again resorting to the submarine system, the eastern coast of Greenland is reached near Graah's Island, in latitude 65°. The telegraph will be brought along the coast of Greenland, underground, to the Danish colony of Juliana's Hope, not far from Cape Farewell, on the Baffin's Bay side; and crossing Davis' Straits by another, and the last submarine line, a station will be reached on the coast of Labrador, where some convenient English factory, such as Byron's Bay, will be selected. From this place, the last great land section of the line will unite with the American system of telegraphs at Quebec—the terminus of an enormous network of upwards of 22,000 miles. Thus will London be placed in immediate electro-telegraphic communication with the States of the Union, the West India Islands, California, and the Pacific. As regards the merits of this project, it is only necessary to point out that they are reducible to the following principal heads. The line will have the advantage of shortness—its entire length being estimated at 2500 miles. As the submarine portion of the line, which, altogether, is one-third less than the direct course, is not in one entire piece, damage done at one particular spot will not involve the ruin of the whole, but will apply only to the particular section in which it occurs. Along this line, the soundings are highly favorable; and, by the course adopted, the enormous beds of fuci, which, according to Humboldt, cover a surface of 260,000 square miles, and extend to 45° of north latitude, are completely avoided, and the obstacle removed which they would otherwise present to the submersion of the line. The exertions, too, of the Messrs. Harrison, by negotiation with the Danish and Canadian governments, and by consulting all authorities on Iceland, Greenland, and Canada, with reference to the permanent security of the land sections of the line through those countries, have imparted to the whole project an aspect of promise, which assures of its speedy incorporation by royal charter, which we shall be among the first to hail with satisfaction.

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[For Appletons' Mechanics' Magazine.]

Notes on the Ericsson.

BY "MACHINIST."

COMPLETE information concerning the engines of the Ericsson being, for various reasons, withheld from our investigation, I have collected, almost at random, the following details, in order that the engineering public may possess, in a convenient form, all the data which is yet abroad. Containing little that has not before been published, it lays no claim to originality; and from the heterogeneous and unofficial, and notoriously imperfect nature of its source, the daily press, a liberal allowance must be made for errors. I have added a few generally received facts with regard to the scientific points involved, stating my authority in most disputed cases, and adding a few deductions, which are naturally derived from the facts laid down.

The degrees are all Fahrenheit's scale. I assume heating 1 lb. water 1° = 1 unit of heat; raising 1 lb. weight 1 foot high = 1 unit of power. The calculations are all on one pair of working and supply cylinders.

DIMENSIONS OF THE ERICSSON.

Length on deck	260 ft.
“ of keel	250
Breadth of beam	40
Depth of hold	27
Draught of water on trial trip	17
Diameter of wheels	32
Length of bucket	10½
Breadth of bucket	20 in.
Dip of wheel (*supposed about*)	2 ft.

ENGINES.

Number of working cylinders or single-acting air-engines	4
Diameter “ “ “ “	168 in.
Area of piston	22167·0773856 sq. in.
Stroke	6 ft.
Portion of stroke from commencement at which air is “cut off,” about	$\frac{63}{101}$
Cubical contents of each working cylinder	1596024 cub. in.
Cubical contents of $\frac{63}{101}$ of working cylinder	995495 cub. in.
Number of supply cylinders or single-acting pumps	4
Diameter “ “ “	137 in.
Area of piston or plunger	14741 sq. in.
Stroke, necessarily	6 ft.
Cubical contents of each pump	1061352 cub. in.
Number of regenerators	4
Number of disks of iron-wire netting in each regenerator	50
Height of each disk	6 ft.
Width	4 ft.
Size of wire	$\frac{1}{16}$ in.
Ratio of area of openings in the netting to total area of disk	½ to 1
Total area of opening of “air way” through each disk, $\frac{6\times4}{2}=$	12 sq. ft.
Greatest or total heat of air in working cylinder above atmosphere	384° F.
Heat of issuing air above atmosphere	30° F.
Pressure necessary to move the engine	½ lb.
Coal consumed in the four furnaces per day	6 tons.
Maximum coal possible to consume in the four furnaces per day	7 “
Number of smoke-pipes	2
“ air-pipes	2
Height of each smoke and air-pipe above deck	12 ft.
Diameter “ “	30 in.
Amount of air passing through the four cylinders per hour	50 to 75 tons.
Depth of working piston, or thickness	6 ft.
Thickness of cylinder bottom	1½ in.
Distance of grate from bottom of cylinder	5 ft.
Ordinary pressure of the engine per square inch	12 lbs.
Actual pressure on the second trial trip, January 11	8 “
Number of revolutions under pressure of 8 lbs., on trial trip	9
“ “ expected with 12 lbs. pressure	12
Miles per hour obtained on trial trip, Jan. 11, allowing for tide, &c.	7
“ “ expected with 12 lbs. pressure	10 to 12
Number of meshes in each disk	500,000
Temperature in working cylinder, 60° + 384° =	444°
Common temperature of the atmosphere (*usual assumption*)	60°
Specific heat of air—water being 1·0000	·2669
Common pressure of air per square inch = 14·73 lbs., say	15 lbs.
Weight per cubic foot, common pres. and temp., = .0752914 lbs., say	$\frac{1}{13}$ lb.
Density of air, temp. remaining constant, is directly as the pressure.	
Weight per cubic foot, at 12 lbs. pressure, common temperature	$\frac{27}{195}$
Expansion of air at 32° for each degree added, according to *Rudberg*, $\frac{1}{493}$; *Dalton and Gay-Lussac*, ·00208; *Regnault*, $\frac{1}{491}$; *common estimate*	$\frac{1}{480}$
Expansion of air at 60°, for the 384° added	$\frac{384}{508}$
Density of air at (60° + 384° =) 444°, comp. with air at 60°, as	$\frac{508}{508+384}$ to 1
Weight of a cubic foot at 12 lbs. pres., temp. 444° = $\frac{508}{892}\times\frac{27}{195}=\frac{13716}{173940}$	lb.
“ 995495 cub. in., “ “ “ $\frac{995495}{1728}\times\frac{13716}{173940}=$	46 lbs.
Therefore, air passed through each cylinder each stroke	46 lbs.
W't of 1061352 cub. in., at com. temp. and pres. = $\frac{1061352}{1728}\times\frac{1}{13}=$	47·153 lbs.
Therefore, air passed each pump, each stroke	47 lbs.
Allowance made for clearance, leakage, &c., per stroke, 47 — 46	1 lb.

Units of heat req'd to raise 47 lbs. air 384° = 47 × 384 × ·2669 = 4817 units.
“ “ retained by the 47 lbs. on escap'g = 47 × 30 × ·2669 = 376 un.
“ “ transferred by the regenerator each stroke.......4441 units.

Absolute theoretical consumption of heat, per stroke, per cyl....... 376 un.

Mean pressure, per sq. in., on working piston, allowing for continued addition of heat while expanding, initial pres. being 12 lbs., *about* 10·8 lbs.

Mean force acting upon working piston.........10·8 × 22167 = 239408·6 lbs.

Mean resistance per sq. inch to supply piston, commencing with 0, and increasing to 12 lbs., at which pressure it continues to end of stroke.

[The mean resistance in compressing an elastic fluid may be found by reversing the ordinary calculation on expansive working.

The hyp. log. of $\frac{15}{27}$ is ·588] 1·588 × 12 × $\frac{15}{27}$ = ...10·5555 lbs.

Mean resistance against supply piston.........10·5555 × 14741 = 155598 lbs.

Balance tending to move the engine...........239408 — 155598 = 83805 lbs.

Units of power theoretically obtainable per stroke = 83805 × 6 = 502830 un.
“ “ “ “ from each unit of heat..1337 units.

COMPARED WITH STEAM.

1 lb. of water raised to steam requires 990 + (212 — 60) = 1142 units of heat.
“ steam at atmos. pres., without expan., creates 58890 units of power.

Expanding twelve fold increases effect..............................3·5 fold.

[Working at higher pressure increases effect....................*ad infinitum.*]

Units of power theoretically obtainable from each unit of heat in using low pressure steam, expanding twelve fold = $\frac{58890\times3\cdot5}{1142}$ = ...180 units.

Effect of heat in low-pressure steam-engine, 180; *in Ericsson air-engine*, 1337.

Units of power theoretically obtainable from each unit of heat in an air-engine, *without* a regenerator = $\frac{502830}{4817}$ = ...104·386 units.

It will be seen that an air-engine, without regenerator, is not only more cumbrous and impracticable, but less theoretically economical than even a steam-engine working at atmospheric pressure.

There is, in facility for absorbing the heat from the furnace, a difference against the caloric engine, to which I cannot at present approximate. In the steam-engine, the heat from the products of combustion is conducted through ⅜ to ½ inch iron, into water at from 212° to 300°. In the caloric engine, it is conducted through 1½-inch iron, into air at 444°. The transmission of caloric from the furnace into the working medium must be much less perfect in the latter case.

Practically, the Ericsson engine will work as follows, reckoning the various losses in units per stroke:

MATHEMATICAL ANALYSIS OF THE CALORIC ENGINE.

Loss of heat, by escape with products of combustion........(*unknown*) $= a$
" " radiation from furnace, cyl., regenerator, &c. " $= b$
Loss of power, by throttling fresh air in regen. and valve ways... " $= c$
" " " exhaust " " ... " $= d$
" " leakage and clearance, minus the 1 lb. allowed above " $= e$
" " friction .... " $= f$

$1 + a + b$ units of heat $= 1337 - c - d - e - f$ units of power.

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Dimensions of French Locomotives.

We take pleasure in transferring to the pages of the *Mechanics' Magazine* the following, which originally appeared in the *Publication Industrielle*, and has subsequently been reduced to English measures for the *London Artisan.*

Crampton's patent locomotives, as executed by Messrs. Derosne, Cail & Co., of Paris, are in use on many of the French lines, particularly on the Northern and the Strasburg Railways, on the former of which they perform the service at the rate of 56 miles per hour. The dimensions given are those of the various classes actually in use on the Northern line.

Principal Dimensions of the Locomotive Engines employed on the Northern Railway of France.	Crampton's Patent Engines.	Passengers' Train Engine.	Good's Engines.
	Ft. Ins.	Ft. Ins.	Ft. Ins.
Diameter of cylinder	0 15·98	0 14·96	0 14·96
Length of stroke	1 10·04	1 10·04	2 0
Diameter of driving-wheels	8 10·67	5 8·97	4 0
Proportion of speed of wheels to pistons.	6·3 : 1	4·71 : 1	3·14 : 1
Diameter of leading wheels	4 5·14	3 3·37	4 0
Diameter of trailing do.	4 0	3 3·37	4 0
BOILER.			
Length inside fire-box, upper part	4 4·96 4 5·94	3 0·42	3 0·42
Breadth, lower part	3 3·96 3 6·53	2 11·98	2 11·98
Length outside	5 1·023	3 5·29	3 6·29
Breadth outside	4 1·02	3 7·46	3 7·46
Width of spaces, extreme { above below	0 4·04 0 3·54	0 3·94	0 3·94
Width of spaces at side	0 3·94	0 3·74	0 3·74
Total height inside fire-box	4 5·54	4 6·34	4 3·34
Outside diameter of barrel of boiler	3 3·37	3 2·19	3 2·19
Length of cylindrical part between the plates	11 7·76	12 1·08	12 1·06
Length of tubes	11 7·76	12 1·08	12 1·06
Number of do.	178	125	125
Outside diameter, which is reduced to 1·81 inches at fire-box end	0 1·97	0 1·93	0 1·93
Inside diameter of do.	0 1·81	0 1·77	0 1·77
Distance from centre to centre	0 2·56	0 2·44	0 2·44
Outside length of smoke-box	4 1·01	3 9·96	3 9·96
Breadth over the plates	3 0·92	2 6·31	2 9·98
Total length of inside boiler over fire-box.	18 6·80	19 0·85	18 7·85
Thickness of copper plates of fire-box	0 0·47	0 0·48	0 0·48
Do. tube-plate across tubes	0 0·98	0 0·9	0 0·9
Do. plates in boiler barrel	0 0·39	0 0·39	0 0·39
Do. plates of shell of fire-box	0 0·47	0 0·47	0 0·47
Do. do. tube-plate (iron)	0 0·59	0 0·59	0 0·59
Do. do. smoke-box	0 0·39	0 0·31	0 0·31
Height from bottom of fire-box to cylindrical part	1 8·08	1 10·15	1 10·15
Height from do. to lower part of dome	5 9·09	7 8·20	7 8·2
From top of rail to bottom of fire-box	0 11·81	1 7·80	1 3·75
From do. to cylindrical part	2 7·89	4 0·08	3 7·72
From top of rail to top of chimney	13 1·48	15 1·48	15 1·48
Height of cylindrical part above driving-axle	0 9·45	1 2·96	1 7·88
Outside diam. of the chimney { top 1 2·64 1 3·17	bottom 1 4·22 1 5·72	1 1·39	1 1·39
Thickness of chimney	0 0·24	0 0·24	0 0·24
Height of chimney above smoke-box	6 4·57	5 7·32	5 11·06
Direct heating-surface in fire-box, in square feet	103·65	0 55·11	0 55·11
Heating surface in tubes	1010·5	715·8	715·6
Total heating surface	1114·15	770·91	770·91
Space available for steam, in cubic feet	85·81	33·93	33·93
DIMENSIONS OF FRAMING.			
Length from end of foot-plate to fire-box.	1 3·74	1 3·74	4 6·92
Total length on exterior of boiler	18 3·68	18 6·83	18 8·8
Length from smoke-box to end	0 9·84	0 9·84	0 4·92
Total length	20 5·26	20 8·41	23 8·64
Depth of framing	0 9·84	0 7·87	0 7·87
Thickness of framing	0 0·98	0 1·18	0 1·18
Height of upper part of do. above rails	3 5·88	4 1·5	3 5·78
Height of do. above driving-axle	2 11·43	1 4·78	1 5·71
Distance between centre of frames	4 2·0	4 0·26	4 6·26
Distance between fire-box and hind axle.	0 9·05	0 5·11	0 4·72
Distance between hind axle and driving axle	3 4·39	4 11·25	4 0·83
Distance between driving and leading axles	6 4·77	5 2·90	5 3·97
Distance between leading axle and smoke-box	1 2·96	1 9.26	2 1·69
Total equal to the length of the boiler barrel	11 7·76	12 1·07	12 1·07
Breadth of tires	0 5·51	0 5·51	0 6·51
Thickness of do. at middle	0 1·96	0 1·96	0 1·96
Number of arms in driving-wheel	20	16	12
Diameter of seat of the driving-wheels	0 7·87	0 7·08	0 7·08
Thickness of boss of driving-wheels	0 7·71	0 7·48	0 7·08
Diameter of journals of driving-axle	0 6·49	0 6·3	0 6·3
Length of journals of do.	0 10·23	0 5·9	0 5·9
Diameter of body of shaft	0 7·28	0 6·1	0 6·1
Number of arms in leading and trailing wheels	14 12	10	12
Diameter of seat of do.	0 9·05	0 6·30	0 7·08
Thickness of boss of do.	0 7·45	0 6·29	0 7·08
Diameter of journals of do.	0 6·1	0 5·51	0 7·08
Length of journals of do.	0 11·81	0 6·3	0 5·9
Diameter of body of axle	0 7.08	0 5·31	0 5·7
CYLINDER, CONNECTING-ROD, &c.			
Thickness of piston	0 4·33	0 4·25	0 4·52
Do. at edges	0 0·78	0 0·98	0 0·98
Length of the cylinder between the covers	2 3·17	3 3·28	0 2·52
Diameter of piston-rod	0 2·33	3 2·16	0 2·16
Length of guides (steel)	0 4·33	0 3·15	0 3·16
Thickness of guides at extremities	0 1·57	0 1·3	0 1·3
Do. do. middle	0 1·96	0 1·69	0 1·89
Length of connecting-rod	3 0·65	4 6·13	4 9·87
Diameter of crank-pin journal	0 4·52	0 4·25	0 3·15
Length of do. do.	0 4·45	0 3·54	0 3·54
Distance from centre of cylinder to centre of frame	0 11·96	0 13·08	0 16·74
Distance between centres of cylinders	6 1·98	6 3·33	6 9·78
Do. backing eccentrics	7 1·35	2 10·29	2 10·29
Do. forward eccentrics	7 5·76	3 2·65	3 2·85
Do. centres of slide-rods	7 3·32	3 0·57	3 0·57
Travel of eccentrics	0 4·72	0 4·56	0 4·56
Inside diameter of do.	0 8·81	0 12·20	0 12·2
Outside do.	0 9·76	0 12·59	0 12·59
Angle of fixing do.	85°	80°	80°
Width of eccentric bands	0 1·98	0 2·26	0 2·26
Thickness of do.	0 1·57	0 1·61	0 1·61
Eccentric rod, length between centres	4 7·12	4 6·78	3 7·98
SLIDE VALVES.			
Length of openings	0 11·41	0 9·84	0 9·84
Inside distance apart	0 5·23	0 4·48	0 4·48
Length outside	0 10·82	0 9·68	0 9·68
Depth inside	0 2·86	0 2·86	0 2·86
Cylinder face, exhaust-port	0 3·74	0 2·99	0 2·99
Distance between the insides of the steam-ports	0 5·31	0 4·56	0 4·56
Distance between the outsides of ports	0 8·85	0 7·71	0 7·71
Width of steam-ports	0 1·77	0 1·57	0 1·57
Inside cover of slides	0 0·39	0 0·39	0 0·39
Outside do. do.	0 0·98	0 0·98	0 0·98
Diameter of slide-rods	0 1·26	0 1·26	0 1·26
Distance of rod from cylinder face	0 2·06	0 2·32	0 4·01
From centre of cylinder to face	0 12·6	0 16·59	0 19·09
Diameter of steam-pipe	0 4·83	0 3·93	0 3·93
Do. exhaust-pipe	0 5·51	0 4·72	0 4·72
GENERAL DIMENSIONS.			
Height of buffer-spindle above rail	3 1·59	3 1·59	3 1·59
Between centres of buffers	5 5·38	5 7·79	5 7·99
Between centres of safety-chains	2 3·56	3 10·85	3 10·85
Height of centre of draw-bar	3 3·37	3 1·59	3 1·59
Height of buffer of tender	3 3·37	3 6·91	3 1·69

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LIST OF PATENTS,

Issued from the U. S. Patent Office during the month of December, 1852.

Robert Bunker, of Rochester, N. Y., for improvement in Machinery for Bending Pail-Bales, &c.

Claim.—The combination of the saddles, brake, bar, and movable block, all operating as described.

L. W. Colver, of Louisville, Ky., for improvement in Seed Planters.

Claim.—Making the cells in the tops of the grooves, so that they shall carry single grains, and combining therewith a cleaner, which extends into the groove behind the seed, as each cell in turn arrives at or over the seeding tube, for the purpose of carrying around and depositing with certainty the seeds or grains, singly, substantially as described.

R. S. Cramer and C. C. Blossom, of Somerville, Ohio, for improvement in Saw Gummers.

Claim.—The nut, having gudgeons occupying notches in one of the jaws of a saw-gumming apparatus, in which the cutting portion is situated between the power and the fulcra for the objects explained.

Chas. W. Coe, of Ashtabula, Ohio, for improvement in Drilling Machines.

Claim.—First, the peculiar manner of giving the slow automatic feed-motion to the spindle, and the fast receding motion, by means of the sliding pinion, collar, and screw, which is attached to the spindle, combined with the two sets of cogs, or their equivalents, upon the face of the same disk, the several parts above-named being constructed, arranged, and operating in the manner and for the purpose described.

Second, the peculiar method of constructing and arranging the clutch, by which the inclination of the clutch may be changed, as described, and the position of the clutch also moved or changed bodily in a horizontal direction.

Francis Degen, of New York City, for improvement in Hats.

Claim.—I am aware that metallic rings or bands have been used in helmets and similar articles, for the purpose of a support, but I do not know of any hat in which a strip of foil has been inserted between the leather or sweat and the hat; therefore, I claim the metallic strip or strips inserted between the leather or sweat and the hat, and attached to either, or both the hat or sweat, as described.

Phineas Emmons, of New York, for improvement in Tongueing and Grooving Apparatus.

Claim.—The shaft, connecting-rods, cutter-stocks, cutters, and slides, in combination with the stationary tonguers and groovers, for the purpose of tongueing and grooving boards, &c., as set forth.

Stephen Gates, of Albany, N. Y., for improvement in Hot-Air Furnaces.

Claim.—The combination of the deflecting plates, with the system of upright flues directly over the fire-chamber, when such flues are arranged in the manner set forth, so that each flue of itself shall act as a deflector and insure a complete circulation through the whole system, substantially as described.

E. L. Gaylord, of Newark, N. J., for improvement in Bending Carpet-Bag Frames.

Claim.—The employment, for the purpose of bending and forming carpet-bag frames, or for bending two or more flat metal bars edgewise, for any purpose, of a pair of clamps, each moving independently of the other, in the direction of the width of the bars, and having recesses and self-adjusting movable pieces, as described, combined in any way substantially as set forth, with a table and bending plate.

C. B. Brown, of Griggsville, Ill., for improvement in Grain and Grass Harvesters.

Claim.—The combination of the crown-wheel, with the shafts, with their respective pulleys, acted upon alternately by the cogs of the wheel, the shafts being connected so as to turn in opposite directions, whereby a vibratory motion is given to the blade.

I do not claim either of these singly, but when combined, for the purpose and in the manner substantially as described.

Louis Drescher, of New York City, for improvement in Galvanic Battery.

Claim.—The improved arrangement of the old voltaic pile, the same consisting in so separating each galvanic pair from that next it in the series, and connecting them with short wires, and forming the plates with suitable perforations, as that the strips of leather or flannel, or their equivalent, may be at once saturated with the exciting liquid, by immersing the battery therein.

George Grant, of Troy, N. Y., for improvement in Hinge for Moulders' Flasks.

Claim.—A hinge for moulders' flasks, constructed substantially in the manner as described, by means of which the cope is raised in the jaws of the hinge, as set forth.

J. T. Hammitt, of Philadelphia, Pa., for improvement in Chairs.

Claim.—Operating the leg-rest of the chair from the motion of the seat and back, by means of the lever and rod, or their equivalent.

L. E. Hopkins, of New York City, for improvement in Machines for Hat Bodies.

Claim.—The feeding-belts, constructed substantially as described, with jointed chairs, having cloth stretched between them, as set forth, by which their motion is exactly determined and equal.

Also the combination of the revolving endless planking board or table, with the feeding-belts, both moving with the same velocity, for the purpose as described.

Richard Ketcham, of Seneca Castle, N. Y., for improvement in Locks.

Claim.—The circular tumbler, or its equivalent, in combination with the slotted collar, which encompasses the spindle of the knob, said collar and tumbler or its equivalent being constructed and operating as described.

Rhodolphus Kinsley, of Springfield, Mass., for improvement in Padlocks.

Claim.—Giving a forward motion to the hasp, and acting upon the tumblers by means of the same key, when the parts are arranged so that the key acts directly upon a portion of the hasp, substantially as described.

Secondly, the double-acting spring described, only when used in connection with such a form and arrangement of hasp as will cause it to actuate the tumblers, and not only throw the hasp out, but hold it thrown out and fully open in the manner described.

John Levy and C. Jones, of New York City, for improvement in Mode of Frosting Glass.

Claim.—First, frosting and figuring glass, by fixing the plates to be treated in a trough or vessel containing sand, pebbles, and water, and subjected to a short, quick, vibratory motion, in a longitudinal direction, by any suitable mechanical movement, thus causing the glass to pass through the mass of gritty material, before any considerable momentum is imparted to that mass.

Second, forming ornaments upon the glass by the application of patterns or designs, in connection with the process of frosting by the action of the sand and pebbles, as set forth.

John McCreary, of Chesterville, Ohio, for improvement in Wooden Type.

Claim.—The arrangement of the propelling lever, so that, by its return movement, in combination with the feeding lever, spring, dog, and feeding tube, it will move forward, as required, the blank wood to receive the impression, as set forth.

E. H. Pond, of Rutland, Vt., for improvement in Pill-Making Machines.

Claim.—First, moulding or forming pills by means of two cylinders, having each a number of recesses in its periphery, the recesses in one cylinder matching with those in the other, and each matching pair forming a mould of the required form of the pill, the said cylinders revolving in opposite directions, and the pill mass being conducted between them, as described.

Second, the bands of India-rubber or any sufficiently elastic material passing round, or partly round, the mould cylinders, for the purpose of expelling the pills from the recesses, after the moulds are open, substantially as set forth.

Wm. Stoddard, of Lowell, Mass., for improvement in Shingle Machines.

Claim.—The combination of the rifting-knife (connected with the main driver by means of elastic arms) with the inclined planes placed upon the rails, as described, for the purpose of enabling the knife to be carried forwards under the block, during the forward movement of the said driver, and then be elevated to the proper height to split off a shingle during its return movement, as set forth.

Also the arrangement of a secondary driver placed above, and acting independently of the main driver, in such a manner that it will drive the rived shingle from under the block and deposit it upon the bed, in such position that it will be carried forwards to be dressed during the forward movement of the said dresser, substantially as set forth.

J. W. Switzer, of Basil, Ohio, for improvement in Screw-Driver.

Claim.—The screw-driver, spring-catches, attached to the flat portions of the screw-driver, and permitting longitudinal as well as lateral adjustment, and the barrel in which the whole is placed, in combination with the brace and stock, or their equivalents, the whole being constructed, arranged, and operating in the manner and for the purpose substantially as set forth.

Warren W. and Clark C. Wright, of Canton, Pa., for improvement in Reel for Harvesters.

Claim.—First, extending the axle of the driving-wheels, so far beyond the carriage as may be necessary to form a pivot for the reel to turn upon and allow of its rotation, by a band, as described, independent of the rotation of the axle, substantially as set forth.

Wm. H. Smith, of Philadelphia, Pa., for improvement in Slags of Furnaces.

Claim.—The process of utilizing the slags of iron and other like furnaces, refining and working the same, substantially as set forth, whereby I bring into successful operation, for useful purposes, a class of hitherto useless products.

Cullen Whipple, of Providence, R. I., for improvement in Machinery for Making Wood Screws, &c.

Claim.—First, the feeder, composed of a sectional trough, with a close bottom and open top, into which the flank drops and arranges itself before a traversing rod, which pushes it into the griping jaws, substantially as described.

Second, the combination of the traversing rod, actuated substantially as described, with an adjustable stop, for the purpose of setting the blanks between the jaws in the exact position required, as set forth.

Third, the method of operating the jaws and holding them closed with the requisite force to hold the blank firmly between them, without end-strain upon the mandrel, by means of toggle or knuckle-joint levers, which are thrown slightly past centres, when the jaws are closed to hold them closed, when they are used in connection with elastic and long-shanked nippers, substantially as described, whereby all end-strain of the mandrel against its bearings is prevented, during and by the griping and holding of the blank.

Lastly, the spring-discharging punch, constructed and arranged in such a manner that the same shall be compressed by the entrance of the blank between the griping jaws, and shall throw the blank out of the jaws the instant they relax their hold of it sufficiently; such pushing out depending upon such relaxation and the force of the spring, and being entirely independent of the motion of any other part of the machine.

Wm. P. Blake, of N. Y., for improvement in Lining for Iron Safes, &c.

Claim.—The application of amorphous zinc oxide, as a lining for safes and refrigerators, and as a covering for steam-pipes, steam-chambers, locomotive boilers, hot-air flues, and chambers, in such manner as to prevent the transmission or conduction of caloric into or from such chambers or flues.

James C. Forrest and Geo. Baker, of Schenectady, N. Y., for improvement in Trip-Hammers.

Claim.—The employment of the peculiar-shaped movable tappets of different sizes, the said tappets being arranged loosely on the driving-shaft and moved back and forth, or one substituted for the other by means of the lever, in combination with the hammer, having a rectangular notched or peculiarly formed slot cut in it, the whole constructed, arranged, and operated in the manner and for the purpose described.

Likewise, so arranging the lever, that when the large or small tappets are moved from one position to the other, or the small tappet made to occupy the place of the large one, the controlling spring will also be operated upon and made to assume a proper position to suit the size of the tappet, the arrangement for effecting this object consisting of a hook-shaped shifter and movable collar, which are constructed, arranged, and operated in the manner set forth.

Jos. H. Gest, of Batavia, Ohio, for improvement in Field Rollers for Cutting Stalks and Weeds.

Claim.—The employment or use of the knife-roller, said knives being either of straight or spiral form, in combination with the pins and fork, the knives, as the machine moves along, cutting the stalks from the roots, and also the stalks into pieces, while lying upon the ground, and the pins and prongs of the fork drawing the stalks within range of the knives, as specified.

Robert Hinton, of Roxbury, Mass., for improvement in Ball Castors.

Claim.—The improvement in making the case of the ball castor, viz., of a combination of two halves or parts, the curved lip, and the ring, as constructed and applied together and to the leg or socket ferrule thereof, as set forth.

J. U. Houston, of Conway, Mass., for improvement in Stone Picks.

Claim.—The addition of a guard to the inner side of the hammer of millstone picks, which guard will intercept the chips of stone and protect the hand and person of the picker, using for that purpose the metallic guard described, or any other substantially the same, and which will accomplish the same result.

I do not claim the mode of constructing the pick, as described, in other respects than as pertains to the guard.

Clark Polley, of May's Landing, N. J., for improvement in Buckets for Chain-Pumps.

Claim.—The globular elastic and adjustable bucket, for chain-pumps, constructed as set forth.

Zimri Hussey, of Chilicothe, Ohio, for improvement in Apparatus for Treatment of Fractures.

Claim.—First, the hip-brace of semi-circular or nearly semi-circular form, and the strap passing over it and around the limb, the said strap and brace operating as set forth.

Second, the knee-fork attached either to the upper or lower part of the double inclined plane, for the purpose of attaching a band which clasps the limb, to effect extension or counter-extension at the knee, as explained.

Third, the application of the adjustable braces to the crests of the ilium, substantially as described, the said braces being attached to a seat-piece, or its equivalent.

Fourth, the seat, in combination with an adjustable back-piece, attached to two double inclined planes, substantially as described, for the purpose of moving the cripple without changing the adjustment of the splints, for the purpose set forth.

Henry Nycum, of Uniontown, Pa., for improvement in Seed Planters.

Claim.—First, the construction of the compound grain-slide, as described, by which the amount of grain required to be sown is graduated at pleasure, as set forth.

Second, the mitre bar, constructed as described, to raise the apparatus for lifting the drill-teeth and throwing the sides out of geer, completely out of the way of the operator, thus allowing him to get at the drill-teeth, for the purpose of cleaning them of obstructions, with a facility altogether unknown in machines constructed with a horizontal bar in the rear.

Chas. Abram and Chas. N. Clow, of Port Byron, N. Y., for improvement in Scythe Snaths.

Claim.—A scythe or cradle snath composed of a wrought metal tube, which possesses the advantages of great durability and facility of being bent into any desired form, without increasing its ordinary weight, or impairing its usual strength and firmness.

Also the longitudinal rib, or its equivalent, on the snath, in combination with a series of notches in the ring of the web, for the purpose of adjusting the webs securely upon the snath, substantially as set forth.

Joel Dawson, of Barnesville, Ohio, for improvement in Straw-Cutters.

Claim.—In combination with the rake and spring, the pressure piece and roller, constructed and arranged as set forth.

Wm. Field, of Providence, R. I., for improvement in Machinery for Forging Metals, &c. Antedated June 14, 1852.

Claim.—First, the mandrel, or its equivalent, for chucking or griping the metal to be forged, and holding the same in the proper position, and from time to time changing its position between the reciprocating rollers, in combination with reciprocating rollers, for shaping the metal so held, whose action upon the metal is regulated by a pattern guide, substantially as set forth.

Second, the method of regulating the thickness and shape of the metal being forged, without stopping the rollers or withdrawing the metal therefrom by the simultaneous adjustment of the pattern guides, as described.

Zimri Hussey, of Chilicothe, Ohio, for improvement in Apparatus for Club Feet.

Claim.—The side pieces to which are attached the adjustable foot pieces, connected and adjustable to each other, as described, by the back piece, plates, bolts, and slots.

Harvey Sprague, of Riga, N. Y., for improvement in Plough Regulators.

Claim.—The combination of the arms with the connecting and regulating bar, the arms and the connecting bar forming an arch and working on an axle which passes through the beam, in the manner and for the purpose set forth.

P. P. Trayser, of Baltimore, Md., for improvement in Spike Machines.

Claim.—I do not confine myself to any particular form or arrangement of the several parts of the machine I have just described, provided the spike is headed and pointed by the mode of operation I have described, as a great number of changes may be introduced into the machine, that will not, in any way, affect the principle upon which it works; indeed, the improvements which I have made could be introduced with advantage either separately or together, into various machines now in use.

What I claim is, the combination of the hinged pointing die, pressed forward by a spring, with the guard or stop, or the equivalent thereof, which guides in the die and limits its forward movement, substantially as set forth.

M. D. Wells, of Morgantown, Va., for improvement in Seed Planters.

Claim.—The reciprocating bar, having wings projecting horizontally on the front and rear sides of the same, to scoop the seeds in the discharge apertures, arranged and operating in the manner and for the purpose specified.

Wm. H. Seymour (assignor to W. H. Seymour and Datan S. Morgan), of Brockport, N. Y., for improvement in Grain and Grass Harvesters. Antedated Oct. 25, 1852.

Claim.—The method of supporting the stand for the raker, at the back of the platform, by means of a brace extending to the outer end of the frame, and so arranged as not to impede the action of the rake or the discharge of the cut grain, the several parts being constructed and arranged as described.

Also the method of protecting the geering of the machine from injury by the working and twisting of the main frame, by mounting the said geering in a supplementary metallic frame, constructed as described, and rigidly connected to one end of the main frame, upon which it is mounted, as set forth.

Cullen Whipple, of Providence, R. I. (assignor to the New England Screw Co.), for improvement in Screw Blanks. Antedated Oct. 16, 1852.

Claim.—I do not claim the broad idea of pointing and chasing the blank in the same machine by different cutters, irrespective of the mechanism employed for the purpose, as I have made such a claim in another specification, my claim on this head is restricted to the mechanism described.

I claim the arrangement of the pointing and chasing tools, on the same tool-holder, in such a manner that they are operated by a common motion, as set forth.

Lydoriann Ricketson (admx. of Henry H. Ricketson, deceased), of New Bedford, Mass., for improvement in Cutting Whale Blubber.

Claim.—I am aware that in machines for cutting straw, or such like matters, a cutting cylinder has been made to operate on a bed-roller, and that the knives on the said cutting cylinder have been arranged in a helix upon it. It is not claimed that such constitutes, in any respect, the invention of the said Ricketson, deceased.

But what is claimed is the wheel, composed of two or more spiral knives, made to rotate on an axis, arranged parallel and in the direction of the movement of the strip of blubber to be cut, as set forth, meaning to claim two or more spiral knives, formed, arranged, and made to operate with respect and in combination with a set of bed and feed rollers, substantially in the manner and for the purpose of cutting blubber, as described.

Jearum Atkins, of Chelsea, Ill., for improvement in Rakes to Grain Harvesters.

Claim.—I do not confine myself to the exact mechanical devices and arrangements described, for operating the rake, as they may be modified, or others substituted for them.

I claim the combination of the crane-post, rock shaft, and crank, to operate the jointed arm and hands, which collect the grain in gavels, and deposit in rear of the harvester, as specified, as the machinery moves forward, when applied to machines for harvesting any grain which requires to be collected and deposited, the combination being connected by geering with the driving-wheel of the harvester, and operating through mechanical devices, substantially as described, as an automaton to perform the above specified operations.

Wm. S. Carr, of New York City, for improvement in Water Closets.

Claim.—I am not aware of any previous arrangement in which an air-tight reservoir has been used, the filling or partial filling being effected by motion of the seat letting on the water, and when the weight is removed from the seat the supply of water is shut off, and a connection opened between the air-vessel or reservoir and the pan or basin of the closet.

Neither am I aware of any arrangement of the parts by which the pressure of water opens the pan, thereby avoiding a separate and distinct operation by hand, always subject to neglect or hasty and improper performance, by which the water has not time to act.

I do not claim any of the parts of the pan, basin, or hopper, as these may be of any desired character, and if used with the hopper-closet without a pan, the parts which move the pan may be dispensed with.

What I claim is the cylinder and plunger, by which the force of the water is made to raise the lever, depressing and emptying the pan, so described.

A. S. Dozier, of Norfolk, Va., for improvement in Ventilators.

Claim.—I do not claim a ventilator with slats or shutters fixed in the side of a cupola or dome, or other structure, placed on the top of the building, or elsewhere; but I claim the arrangement of the frame in the sides of the cupola or dome, projecting slightly beyond the face thereof, to admit the lips or turned ends of the slats or shutters to lap over the same, in order to form tight joints, and the manner of hinging or jointing the slats or shutters to the same by the joint pin.

Likewise, the radial wings when combined with the frame of the dome or cupola, for directing the currents of air to the spaces between the slats or shutters, as described, and thence to the trunk.

Warren Gale, of Louisville, Ky., for improvement in Straw-Cutters.

Claim.—Constructing the rotating cutting cylinder, substantially as described, with a series of parallel annular grooves and ridges, and a series of cutting arms or knives, in combination with a series of fixed knives, so arranged that they enter the grooves and interlock or lap past the annular ridges on the cylinder and thereby prevent the stalks of straw, &c., from descending between the fixed knives and cylinder, without being cut, substantially as set forth.

Wm. A. Gates, of Mount Comfort, for improvement in Ploughs.

Claim.—The rhomboidal plate, bent on one of its diagonals, and constructed and arranged substantially as described, so that either leaf can be used as a land-side or share, at pleasure, the edges of the share becoming, when the plate is reversed, the edges of the land-slide, and those of the land-side the edges of the share, in the manner and for the purposes specified.

Also, in combination with the plane, as described, the double bifurcated brace for attaching said plate to the beam, as described.

L. E. Hopkins, of New York City, for improvement in Machinery for Hat-Bodies.

Claim.—I do not claim the conical vibrating rollers, for the purpose of felting or compressing a hat, or the cone, separately; but I claim combining the hardening rollers with the perforated cone, by means of a yielding or hinged frame in which they are placed.

Also giving to said rollers, in combination with said perforated cone, a vibrating endwise motion, as well as a rotary motion.

Also blowing the exhaust-air from the former into the chamber, for the purpose described.

Also the mode of forming the steam-pipe outlet, as specified, by covering the steam-pipe with the cloth, and in casing it with an outer metal case.

Also covering the perforated cone, preparatory to a deposition of fur thereon, with a covering of thin cloth, easily pervious to air, upon which the fur is to be deposited, said cloth or fabric to be removed at each operation, with the hat-body deposited thereon.

J. Jones and Alex. Lyle, of Rochester, N. Y., for improvement in Grain Threshers and Cleaners.

Claim.—The operation of the upright threshing and separating cylinders with the upright concave and cylindrical sieves operating in the manner set forth.

Wm. H. Morrision, of Indianapolis, Ind., for improvement in Equalizing Apparatus for Engines which use Steam expansively.

Claim.—The application to a reciprocating engine (in which the steam is used expansively), as described, or equivalent toggle movement, in combination with a pair of equalizing cylinders, which being placed at a greater or less distance (one on each side of the mid range of the toggle), the most rapid accumulation of equalizing force is made to take place earlier or later, in the stroke, in accordance with the period of cut-off, &c., for the purpose described.

J. L. Ream, of Mount Pulaski, Ill., for improvement in Maize Harvesters.

Claim.—The arrangement of the shaft of the receiving arms, with one end resting upon the cutter bar-piece, thereby dispensing with an intermediate platform, so that the cut stalks will fall directly upon the receiving arms, and be thence discharged, in bundles, upon the ground, as set forth.

S. W. Rogers, of Baltimore, Md., for improvement in Cut-off Valve Motion.

Claim.—I do not claim passing the cut-off valve outside of the slide-valve, and operating both valves by one rod or eccentric.

But I claim the lugs acting upon the hinged levers, attached, at their lowest extremities, to the cut-off slide, and at their upper to a rod capable of a vibratory movement, in a direction perpendicular to the valve-seat, substantially as set forth.

Jesse N. Seeley, of Forsyth, Ga., for improvement in Potato Diggers.

Claim.—The construction of a potato digger, by the combined arrangement of the knife, wheel, and fork, with the beam, operating substantially as set forth.

Thomas Snook and Stephen Hill, of Rochester, N. Y., for improvement in Lamps for Locomotives.

Claim.—First, the combination of a feeder for supplying oil to the holder, by the combination of two tubes, one communicating with the interior of the reservoir, and the other fastened to a float immersed in the oil of the holder, by which the lamp is rendered self-feeding, in the manner specified.

Second, the construction of the chimney with a broad flat flue connecting its vertical portion, the exterior one of which is constructed as to be forward, or on either side of the prolongation of the chimney of the burner, substantially in the manner and for the purpose specified.

John Swindells, of Manchester, England, for improvement in Chromate of Soda.

Claim.—Having now described the nature of my said invention, and the manner in which the same is to be performed, I claim the process described, for manufacturing the chromate of soda for dyeing.

Wm. E. Underwood, of Middlefield, Mass., for improvement in Fulling Mills.

Claim.—The combination of the stop, mechanism, or its equivalent, with the screw-pulley and the elastic band leading to the pulley on the upper roller whereby the whole machine is stopped, when the motion of the cloth is arrested in the manner described, and ceases to impart motion to the upper roller.

Daniel Walroth, of Chittenango, N. Y., and Lucius Evans, of Manlius, N. Y., for improvement in separating Iron from Furnace Cinders.

Claim.—The combination of the revolving, breaking, and sifting cylinder, with the fan, or its equivalent, substantially as specified.

Caleb C. Walworth, of Boston, Mass., for improvement in Steam Flat-Irons.

Claim.—The steam ball and socket smoothing-iron, as made of a combination of a spherical socketed smoothing block, and a hollow or chambered sphere, with induction and eduction passages, arranged so as to admit steam and discharge condensed water, all substantially as set forth, the block being applied to the sphere in such manner that it may be moved thereon in various directions, transversely, while passing over and against a hat or surface, to be moved, as specified.

Aretus A. Wilder, of Detroit, Mich., for improvement in Planing Machines.

Claim.—I disclaim the invention of planing by a reciprocating plane, which planes on its forward stroke, and feeds the board on its backward stroke, as in other machines of this class. But I claim, in planing machines of this character, clamping the board, when being fed by the backward motion of planes, to the reciprocating bed only, so that it will be free to move over the stationary bed-plate, upon which it is planed, as described.

W. H. Woodworth, of Salmon Falls, N. H., for improvement in Measuring Cloth on the Cloth-Beam.

Claim.—Connecting or attaching a measuring cord, constructed as described, to the cloth, so as to be wound on the cloth-beam with it, in order to indicate the length of the cut desired.

Linus Yale, Jr., of Newport, N. Y., for improvement in Safety Lock.

Claim.—First, in combination with the tumblers or their equivalents, constructed and connected respectively to stops, as described, the spring being an additional device, co-operating with the said tumblers, and springs connected therewith, in rendering the movement and position of the stops to the highest degree uncertain, when an attempt is made to unlock the lock without using the proper key.

Secondly, the wheel and the lever, in combination with the tumblers, constructed as described, or their equivalents, to raise, while in one position, and support the tumblers, that the keyhole shall be equal and smooth to receive the key, and then allow them to be stopped at proper heights, on the key, while a revolution is performed and the bolt moved by the wheel, as described.

Daniel S. Bayles, of Brooklyn, N. Y., for improved Parrel for Yards of Vessels.

Claim.—I do not claim the rocker, simply by itself, a saddle or slide being heretofore used, and fastened into the swallow-tail of the gaft and boom of sailing vessels, applicable to fore and aft sails only. But I claim the combination of the rocker in front of the mast, and capable of a motion in two planes, with the rockers at the side of the same, said rockers being arranged with respect to each other and the yoke, as described.

M. A. Bertolet, L. Kirk, and A. M. De Hart, of Reading, Pa., for improvements in the Method of Obtaining Gold, &c., by Amalgamation.

Claim.—Bringing the ore, in a heated state, into contact with mercury, during the process, as set forth.

Also, the method of heating pulverized ore, by causing it to pass in a shower through a current of some heated fluid, preparatory to bringing it into contact with the mercury, as set forth.

Also, the method of heating the apparatus, the mercury, and the ore, by means of a current of heated fluid, circulated through chambers and pipes, substantially as described, whereby a single current of a suitably heated fluid, and a single system of circulating pipes of a simple construction and compact arrangement, are made to heat the whole of the apparatus that requires to be heated, and to heat the ore in the process of feeding, and the mercury in the process of amalgamating, as specified.

Samuel Carrby, of Ellicott's Mills, Md., for improvement in Winnowing Machines.

Claim.—The combination of the piston, rack-rod, pinion, valves, and eccentric pulley, in connection with a conducting chest and blower, for the automatic graduation or government of the blast through the spouts of a winnowing machine, arranged and operating in the manner and for the purpose set forth.

George Daure, Pascal Nicolas, and Felix Lopez, of Marseilles, France, for improvement in the Process of making Illuminated Gas.

Claim.—The combination of woody and fatty substances in gas generators, as described, so that the excess of hydrogen in the former may combine with the excess of carbon in the latter, and produce a rich carburetted gas of any required density, and free from sulphurous fumes.

Elihu and Warren W. Dutcher, of North Bennington, Vt., for improvement in Temples for Looms.

Claim.—The arrangement of parts so that the temples have a reciprocating action, corresponding with the motion given to the cloth by the beat of the lay, substantially as set forth.

John P. Farnum, of Andover, Mass. (assignor to Jacob Jenkins and Chas. B. Clark, of same place), for improvement in Cutting Paper.

Claim.—I do not confine my invention to the precise form or arrangement of its parts, as represented, but intend to vary the same to any extent, while I do not change the character of the machine.

What I claim is the combination of a press, or its equivalent, for holding the book or paper to be cut, with one or more cutters or knives for trimming the front or one edge, and one or more cutters for trimming one or both of the other edges of the book, the different sets of cutters being simultaneously operated while the paper or press is moved towards them all, substantially as specified.

And in combination with such cutters or knives for trimming one edge or the front, and other edge or edges of a book at one operation or time, I claim the improvement of combining with them, or either of them, one or more polishing surfaces, or their equivalents, whereby the edges of the sheets of paper are cut and polished, or smoothed, or ready for gilding, as specified.

Pierce Saulnier, of New York (assignor to John T. Bruen, of same place), for improved Mode of Mounting the Cutters of Machines for Planing Metals, &c.

Claim.—I do not limit myself to the special mode of construction specified, as this may be changed at pleasure, so long as the principle or character of my invention is retained.

What I claim is hanging the cutters to the stock by means of a joint pin or its equivalent, whose axis is diagonal to the line of cutting motion, and in a plane parallel with the surface being cut, for the purpose of relieving the cutting edge in two directions, when the cutter-stock is set perpendicular to the plane of the surface to be produced.

Also combining together in one cutter-stock two cutters, hung substantially as specified, and with the angle of the axis of the two joint pins reversed, as specified, for the purpose of relieving both cutters from the two surfaces, when cutting in both directions.

Royal E. House, of N. Y., for improvement in Magnetic Printing Telegraph.

Claim.—First, the employment of electric-magnetic force, in combination with the force of a current of air or other fluid, so that the action of the former governs or controls the action of the latter, for the purpose described.

Second, the construction of the electro-magnet, as described; that is to say, a series of fixed magnets, in combination with a series of movable magnets, arranged upon a central axis, which axis plays between or through the line of fixed magnets, so as to effect a vibratory movement of said axis by a force multiplied by the number of magnets of both kinds.

Third, the combination of the electro-magnet with the valve, for regulating and directing the force of a current of air or other fluid, acting as a motive-power upon the piston, or other analogous device for producing a vibratory motion, as described.

Fourth, the endless band, in combination with the cylinder, as an inking machine for conveying and applying the coloring matter to the paper, at the moment of receiving the impression from the types, as described.

Fifth, the combination of the regulating bar, with the type-wheel, for the purpose of regulating the proper position said wheel should have, in connection with a given position of the key-shaft, at the moment of printing any letters or characters.

Edward Page, of Albany, N. Y., for machinery for Heading Bolts, &c.

Claim.—First, the combination of the stationary die and die-pivot with the sliding hammers, actuated by the rotary grooved cams or cam-collar, as described.

Second, the revolving ring or cam-collar, provided with cams or their equivalents, on its inner and outer surfaces, when arranged with radial compressing and sliding upsetting hammers, in the manner described.

Wm. Tucker, of Blackstone, Mass., for improvement in Shuttles for Looms.

Claim.—The combination of the elevator, bent spring, platform, and its recess, passage, and slot, as applied to the shuttle and cop-spindle, and made to operate together, substantially in the manner and for the purpose of causing the filling thread to be broken, so that no filling thread shall be woven into the warps under circumstances as stated.

Wm. E. Ward, of Portchester, N. Y., for improved method of Heading Screw Blanks, Rivets, &c.

Claim.—In combination with the swedge-header and die-plate, the giving of a back or receding movement at the end of the heading operation to the follower, against which the point of the rod rests during the heading operation, that the rod or wire may be upset, outside of the die, whilst resistance is made by the follower against the end of the rod, and then as the follower retires, cause the part so upset to be griped between the surface of the die and the swedge, to complete the form of the head, the surplus metal being thereby forced into the blank, as set forth.

Henry Waterman, of Williamsburgh, N. Y., for improvement in Safety Apparatus for Steam-Boilers.

Claim.—First, the safety-chamber and safety-plate combined with the boiler in any way substantially as described, whereby the bursting of the plate, by the too high pressure in the boiler, causes the chamber to be filled, and the pressure in the boiler to be reduced by the expansion of the steam.

Second, the plate placed between the boiler and safety-plate, having one or more small openings through which the steam is allowed to pass to act on the safety-plate and fill the safety-chamber, whereby the water is prevented from priming or foaming, and being carried up by the steam when the safety-plate bursts.

John F. Winslow and John Snyder, of Troy, N. Y., for Machinery for Making Railroad Chairs.

Claim.—The movable cutter for making the cuts in the edges of the plate, substantially as described, in combination with the slides, which answer the purpose of stationary cutters and rests, to effect the partial bending of the lips, and which afterwards complete the bending of the lips, as described.

Also, in combination with the cutter, as described, the making of the mould or former, to slide therein, for discharging the chair after it has been formed, as described.

Also the dies for upsetting and giving additional thickness to the lips, as described, in combination with the bending sides and cutter, substantially as described.

Wm. Yarnall, of Newark, Ohio, for improvement in Daguerreotyping.

Claim.—Producing ornamental borders and designs of different shades and forms, and singly or in numbers, around any photographic image, by the method of irregular chemicalization combined with the use of pattern slides, or chemical cut-offs, all of which is described.

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Preserving Timber.

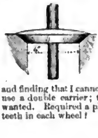
A LETTER from Canada gives the following history and account of a new method of preserving timber, and which the writer thinks will be resorted to in that country: "The method was discovered by WILLIAM MEYER, who lives near Hamburg, in the Duchy of Mecklenburg. He devoted several years to experiment before he perfected the process. A brother of his, who has been a resident of Canada for twenty years, was in Germany last winter, and he brought with him specimens of the preserved wood which have been done six years. The wood is pine, but its character is entirely changed by the process of preserving. The whole body of the wood, every fibre of it, is thoroughly impregnated with the preserving preparation. It is done when green. The native sap is excluded by the process, and the preparation with which it is saturated excludes the action of the air on the internal fibres, and is said to render decay impossible. The wood, when preserved, is heavier than before; and pine or basswood assumes all the qualities of hard wood. It takes a beautiful polish; one of the surfaces of the pine I have seen makes this quite certain. So much for appearances. The value of such a discovery, in a great measure, defies all test but that of time; still there are other criteria that may help to determine the point. The celebrated LIEBIG has examined specimens of the preserved wood, and has given his opinion that the invention is but a re-discovery of the ancient system of embalming the dead, applied to a new purpose, and that he is highly impressed with its utility as a means of preserving timber. A company has been formed in the Duchy of Mecklenburg for carying on the process on a large scale. The inventor has brought it before the attention of the British Government, with a view to induce its adoption in the navy. The preserved wood loses its high combustible qualities; it may be gradually reduced by fire, but will not blaze; it is possible to impregnate it so deeply as to render it incombustible, and this could be done in the case of shingles. It also imparts great flexibility to the wood, and prevents the ravages of worms. The preserved wood will neither shrink nor expand. If this invention be all that is claimed for it, it will be invaluable for railroad purposes, ship-building, roofing, bridges, and every purpose in which wood is exposed to the influence of the atmosphere. Three hours are said to suffice to saturate every fibre of the wood with the preservative preparation. The process is very cheap. It could be done for from a half a cent to a cent and a half a cubic foot, according to circumstances. A mile of railroad timber could be preserved for about one hundred dollars. What principally makes the process so cheap is the incidental circumstance that in the preparation of the preserving liquid, the wood burnt can be made into charcoal.

Apprentices' Department.

THERE are few pleasanter or more effectual inducements to self-culture than will be found in the investigation and discussion of the simple queries which will be presented, from time to time, in this department. We invite to them the attention of the young and curious readers of the *Mechanics' Magazine.*

PROBLEM 1.—(*In Mechanics.*)—Suppose a horse able to pull with a force of 500 lbs. Let two horses be connected by a rope, and allowed to pull against each other, what will be the strain on the rope?

PROBLEM 2.—(*In Chemistry.*)—Why do potatoes become sweet by being exposed to frost?



PROBLEM 3.—The diameter of the orifice of a safety valve is 4 inches, the weight on the lever is so adjusted as to press on the valve with a force of 1000 lbs.; what is the area of the valve, and at what pressure will the steam begin to blow off?

PROBLEM 4.—I wish to cut a screw with 18 threads per inch, with a slide lathe whose main screw is ¼ inch pitch, and which moves the cutter by being driven from the lathe spindle in the usual way; I wish to know what sizes of wheels will effect this, and finding that I cannot geer up with two wheels and a single carrier, I must use a double carrier; that is, two driven and two driving wheels will be wanted. Required a plain, simple, and ready way for finding the number of teeth in each wheel?

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Reviews.

The Marine Steam-Engine, designed chiefly for the use of the Officers of her Majesty's Navy. By THOMAS J. MAIN, M. A. F. R. Ast. S., Mathematical Professor at the Royal Naval College, Portsmouth; and THOMAS BROWN, C. E. R. N. Second Edition.

This octavo volume of about 400 pages was prepared, as its title indicates, for the especial use of the engineers, commanders, and other officers of the Royal navy. It is without plates or other illustrations except of the most elementary nature, and contains little of interest to constructors or designers of engines, but will be found in the highest degree valuable to those having the care or supervision, in any capacity, of the actual working of a marine steam-engine. Difficulties are anticipated, and remedies pointed out, and provision made as far as possible for all the various accidents and contingencies of sudden steaming and stopping, leaking, breakages, &c., to which all marine engines, especially those in government service, are supposed to be liable. The volume before us is a second edition, and has been re-arranged and supplied with "whatever additions the authors' own experience, or the suggestions of naval officers conversant with the subject, may have rendered advisable.'

Industrial Drawing, by D. H. MAHON, LL. D., Prof. of Civil Engineering, &c., in the U. S. Military Academy.

This is admirably adapted to the use of schools and academies for which it is more especially designed. It supposes on the part of the student a tolerable acquaintance with technical and scientific language; the omission of more full explanations in these respects being readily supplied by any competent teacher. The work comprises the description and uses of drawing instruments, the construction of plane figures, projections and sections of geometrical solids, architectural elements, mechanical and topographical drawing. With the exception of the latter, it appears confined to instrumental drawing, a branch of instruction which should long since have become prominent, especially in the male department of all schools of any pretensions. "Industrial drawing is to the artisan what writing is to all," and cannot be too well understood, even by those whose business may never lead beyond the mere execution of the work represented in this manner. 156 pages. 8vo. $2.

A Treatise on the Economy of Fuel, by Alfred P. Ryder, Capt. Royal Navy.

The immediate object contended for in this book is economy in naval service, but many points treated on bear directly on the application of power in every present or prospective manner to navigation. It is by no means an elementary or popular treatise, in the usual sense of the terms, but assuming to write to engineers and naval officers, the writer goes directly at his subject, and elucidates every point with the clearness of a Lardner. Without presenting any special claims to originality (a word often synonymous on questions of this kind with crude and erroneous theories,) this little book of 100 pages will be welcomed by all interested in the marine branch of the profession. The following investigation, furnished by Mr. Roughton, the instructor in steam of the naval students at Woolwich dockyard, we select as one of the more profound, and at the same time of the greatest general interest:

RELATION BETWEEN THE AREA OF THE IMMERSED SECTION OF THE SHIP, THE INDICATOR HORSE-POWER, AND THE SPEED OF STEAMERS IN STILL WATER.

Speed varies as the square root of the resistance, which is equal to the load on the piston diminished in the ratio of the propelling radius of the paddle-wheel to the mean effective leverage of the crank; the radius of the wheel being measured to the point, which is assumed to be the centre of propulsion, this we will place at one-third of the dip from the outer edge of the float; the load on the piston being obtained by multiplying the area of the piston by the effective pressure of the steam as ascertained by "Indicator." The resistance will vary as the area of the greatest immersed section of the ship, which may be approximately represented by multiplying the breadth by the draught minus one-tenth of the breadth.

It is generally supposed that increase of length diminishes the resistance, but the experiments of M. Bossut show that this is not appreciable within the limits of the proportions of steamers. The resistance of angular prows of 12° and 24° he represents by the numbers ·4063 (See Gregory's *Mechanics*) and ·3999. Steamers in which the mean angle is 12° have a length equal to 9½ times their breadth; those whose mean angle is 24° have their ratio of length and breadth as 4·7 to 1, which comprises all cases that occur in practice.

Therefore let d = the diameter of the cylinder, in inches.
f = force effective in moving the piston, per square inch.
s = stroke of piston, in feet.
w = effective diameter of paddle-wheel, in feet.
n = number of cylinders.

Then $n\,(d^2\cdot7854\,f)\,\frac{2\,s}{w\times3\cdot1416}$ = the resistance of floats.

Again, let B = breadth, in feet.
$D = \text{mean draught} - \frac{\text{breadth}}{10}$ in feet.
v = speed of ship, in knots per hour.
c = a constant = 1·6, and therefore $\frac{c}{2} = \cdot8$
$\frac{B\,D\,v^2}{c}$ = resistance of ship.

$$\text{Whence}\ \frac{B\,D\,v^2}{c} = d^2\cdot7854\ f\,\frac{2\,ns}{w\,3\cdot1416} = \text{the pressure on the floats.}$$

$$\text{and}\ \therefore v^2 = \frac{d^2\,f\,s\,n}{w\times B\,D}\times\frac{c}{2}$$

Name of Ship.	Length.	Breadth.	Draught.		Cylinder.			Diameter of Wheel.	Float.			Immersion.	Speed of Ship.	*Calculated Speed.*	Area of immers'd section.	Rev's of Engine per min.
			Fore.	Aft.	Diameter.	Stroke.	Effect. Press.		No.	Length.	Breadth.					
	Feet.	Feet.	Feet.	Feet.		Feet.				Ft. In.	Ft. In.	Ft. In.				
Terrible (by log)............	226	42·6	18·5	19·0	Double Cylinder 72 in.	8	16·75	34	30	12·10½	2·8	7·0	10·9	**11·09**		
Bee (Long Reach)...........	65·6	12·1	3·6	3·8	Sing. en. 20 in.	2	22·2	8·9½	20	3·6	0·9	1·0	7·0	**7·7**		
Banshee (Long Reach)......	189	27·2			72	5	22·63	25·0	12	9·0	3·9	5·0	16·0	**15·9**	208·25	
Llewellyn (Long Reach)...	190	26·7	8·7	9·0	68	6	24·0	27·8	16	8·6	4·0	4·10	15·9	**16·2**		
Sphynx........................	180	36·0	12·6	13·6	62⅝	6	15·0	27·2¼	26	9·0	2·4	4·9	10·5	**11·0**		
Vivid (Long Reach).........	150	22·0	6·6	6·11	49¼	4	22·63	20·0	12	7·0	3·0	4·0	14·57	**14·4**		
Basilisk (Porta) Feb. 27, '50			14·10	15·9									10·551			20¼
* Ditto (at the Nore)	190	34·5	14·11	15·10	74	6	17·19	24·0			2·3	5·3	10·6	**10·3**	415·0	19
Garland (Long Reach)......	140	21·0	6·8	7·0	$43\frac{9}{16}$	4	22·6	18·0	12	6·10	2·10	3·4½	13·83	**13·1**	114·5	34
Elfin (Long Reach)...........	103	14·0	4·0	4·3	26	2·6	20·0	11·2	9	5·0	1·11	2·0	12·18	**11·9**		
* Magicienne (Nore).........	214	38·8	15·6	16·2	72	7	18·6	27·4	28	9·0	2·0	5·2	10·6	**10·1**	45·9	18·06
Onyx (Long Reach, but a different indicator)......	130	21·0	Mean. 6.10		43½	4	20·9	16·6	12	6·10	2·10	4·1	13·16	**12·6**	112·0	33

N. B. It would be more correct to deduct 1½ lbs. for friction; but I have not yet thought it advisable to give the calculation an appearance of refinement, since I have not the exact areas of the immersed sections, nor means of ascertaining that different indicators give precisely the same result; moreover, I find that all those ships that were tried at the Nore, marked thus *, are faster than my calculation, which agrees with those tried at Long Reach.

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Miscellaneous Paragraphs.

STATISTICS OF ANTHRACITE AND CUMBERLAND COAL.—The statistics of the anthracite trade may well awaken surprise. This trade is only about thirty years old. In 1820 the entire shipment was 365 tons. Think of it.

In 1830..tons 142,734
In 1840.. 876,048
In 1850, it reached the enormous quantity of 3,332,314

And still further to show at what a rapid ratio the demand is increasing, in 1851 the amount was 4,383,736 tons, an increase over the preceding year of more than a million of tons. Since 1820, more than thirty-three millions of tons have been supplied. It has been confidently predicted, upon calculations based on the past rate of increase, that the demand for anthracite in 1860 will reach ten millions of tons per annum. What will it be in 1870? What in 1880? For the encroachments of coal upon the uses to which wood has heretofore been applied, and the new uses it has discovered, are now accruing more rapidly than before. The statistics of the Cumberland coal trade are more astonishing, and hold out yet a brighter promise. This trade is but nine years old.

In 1843 the sales were ....tons 4,964
In 1851 they were.......................................162,500
And for the current year they may be safely estimated at....450,000

By the report of the Cumberland company, it appears that they send to market (which was over the railroad alone), 400 tons per diem—an amount which, by the restoration of the canal, has been increased, since the date of that report, to six and eight hundred tons; and the directors announce that they expect to transport during the ensuing season, fifteen hundred tons per day or more.

Reply of Gen. Stuart to "Review of Naval Dry Docks of the United States."

Messrs. D. Appleton & Co.

Gentlemen—My attention has been called to an article in the December number of your magazine, purporting to be a "review" of the "Naval Dry Docks of the United States."

I should let it pass unnoticed, were it not that the character of a third party was unjustly assailed, and the possibility that the position you occupy as publishers might give the statements so freely made regardless of truth a credit and importance they could not otherwise obtain.

I shall therefore answer, as briefly as possible, the erroneous and ungenerous allusion made by the individual that wrote the article in question, respecting the truth of the history of the New York Dry Dock, in which Mr. Dixon's connection with that work is mentioned and properly credited, and ask that it may be inserted in the February number of your paper.

The writer, on page 287, in alluding to Mr. Dixon's opinions and statements relative to the iron turning-gates of the dry dock, indulges the following remarks, viz.:

"In the matter of the iron turning-gate" (page 33), he says, "the details have, in many respects, been constructed essentially different from the original plan designed in 1849;" and then adds, "they have been constructed in the following manner" (copying the descriptions which follow, and without acknowledgment, from the report made to the bureau, in 1849, by his *predecessor*, who planned the gate).

"The method of opening these gates was, it is true, arranged by Mr. S.; but how? In the appendix will be found five pages of correspondence between Mr. S. and the contractor for the gate, on the subject of the proper mode of opening them. In this correspondence, reference is had to the opinion and statements of a Mr. Dixon, with whom Mr. S. had also corresponded on the subject—called elsewhere Horatio Dixon, Esq. (Those who have met the gentleman will at once perceive the appropriateness of the designation.) It seems that the opinion of the contractor for the gates and this Mr. Dixon, who was the inspector of the gates, was favorable to the suggestions of Mr. S., the engineer of the gates for the time being (which, by the way, was a remarkable coincidence), and if their opinion was entitled to weight on any subject connected with the gate, it was rather in the cost of a given quantity and shape of iron, in which they had dealt all their lives, than in a matter of which they could have known nothing by experience, as engineers; and yet it will be seen, in this correspondence, that they differed in opinion, as to the amount *saved* to the government, no less than $3000! And this in estimating the cost of a work amounting to $9600. Their opinions on this matter were clearly entitled to great consideration. But supposing that the saving to the government had been double, or even treble, that amount, what would have been the gain? A method of opening the gates which, by the failure of a cog, or the jamming of a pebble, might, under certain circumstances, be the means of ruining a ship, and, on the other hand, a gain of $10,000."

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"Mr. Stuart, in a manner highly becoming to himself, as well as to the position he occupies, endeavors to show, in this connection, by the testimony of this Esquire Dixon, that his predecessor had been guilty of a petty larceny, in taking from the government yard certain condemned plans of his own designing. To those acquainted with the respective parties, the attempt will prove a very happy one.

"These turning-gates were the first entirely *wrought*-iron gates ever constructed, and the merit of their design and construction is due to Mr. McAlpine.

"Who, we may ask, upon reading the account of them in Mr. Stuart's work, would imagine it?"

* * * * * * *

"Floating-gate or caisson (page 38). The usual proportion of the description of this will be found in the Dictionary; but Mr. Stuart, as usual, gives no credit to the design of his predecessor, or if he has done so, it has escaped our observation. They were built in entire accordance with the plans of Mr. McAlpine, and, we believe, are the first vessels of the kind ever constructed of iron.

"The description of the engine and pumps (page 45) next demands our attention.

"It is not easy to fix precisely upon the individual merit when a commission are appointed to prepare plans for a given purpose, but it is easy to say who was *not* of the commission. Mr. S. had nothing whatever to do with the *planning* of the pumps and engine, nor with determining *how* they should be erected. The contract required their delivery complete on the first of January, 1850, Mr. Copeland being charged with the duty of their superintendence; and the board to determine the plan were the *then* engineer of the works, W. J. McAlpine, C. W. Copeland (a prominent mechanical engineer), and Mr. Ellis. They were, however, not completed at the time required, but received some additions and changes. If any one will point out any one of these suggested by Mr. S., we will own we have done the latter individual injustice. * * * Neither the turning-gates, nor the floating-gate, nor the engine and pumps, had he the slightest hand in projecting. It was all contracted for by his predecessor, and built in accordance with his plans; and for the correctness of this statement we hold ourselves responsible."

It will at once be seen by the foregoing extracts, taken from your magazine, that the attempt is made to discredit the statements of Mr. Dixon, "who was the inspector of the iron gates," respecting the taking away of the original plans made by him for the opening and closing of them, and also to ridicule the changes made in the machinery used for that purpose; and, lastly, an expiring effort is made to take from a worthy and skilful mechanic the credit he is entitled to *for designing and drawing the original plans* for not only the turning-gates, but also the floating-gate or caisson, and the pumping-engine, and pumps for the New York Dry Dock, and give it to another, who, he says, claims all the credit, in an article written in the winter of 1850, for Appletons' "Dictionary of Mechanics."

If the individual who wrote the "review" had referred to one or two of the "five pages in the appendix," alluded to above, he would have found Mr. Dixon's testimony, relating to the *original* plans for opening and closing the gates, fully corroborated by the experienced and able contractor, Henry R. Dunham, who is too well known in this community to have his character questioned.

On page 108 of the "Naval Dry Docks," it is stated by Mr. Dunham that he had been shown by the late engineer of the dock (in 1849) the drawings for the capstans and gearing for opening and shutting the iron gates, which he fully describes; and further remarks, in his letter to myself, of October, 1850, that "the last plan, and the one submitted by you, for my consideration, left by the late engineer, as original, is a simple capstan with a fixed barrel, which would not answer at all, because the very first revolution would create an angle in the chain quite fatal to its further use, because of the immense friction against the quoin posts' journals, and in the capstan itself. Your invention is the only one applicable and proper to be used for the purpose; and, if executed with due consideration to its importance, will, at my contract prices, cost $9668 50."

In my letter to the Bureau of Yards and Docks, of October 10, 1850, given in a portion of the "five pages of the appendix," is the following: "It will be seen that Mr. Dunham refers to a plan submitted to him by the late engineer, Mr. McAlpine, at the time he put in his proposal for the building of the gates, and which was estimated to cost from fifteen to sixteen thousand dollars, at his prices, as proposed.

On inquiring of Horatio Dixon, the machinist on this work, I learned that he did, *last* year, at the request of the engineer, *design* and *draw out a plan* for the opening and shutting of the turning-gates, similar to the one described by Mr. Dunham, in the inclosed letter, and which Mr. Dixon estimated to cost about the sum there named, exclusive of an expenditure of from four to five thousand dollars, to fit the work to the masonry of the dock—making the whole cost about twenty thousand dollars. The plan thus made, Mr. Dixon informs me, was taken by the late engineer, with other drawings, last fall, and no copy left, to his knowledge. Upon examining the plan left in this office, it was seen that it was entirely *impracticable* for the purpose intended, and therefore its construction would be useless. I at once suggested the plan submitted to the bureau last August, and directed Mr. Dixon to draw out the *details*, which he has done with his usual skill and judgment, and now estimates the cost at less than *half* the original plan, and the machinery much superior, and altogether more simple, and better adapted, in every particular, to accomplish the desired result. In this opinion, it will be seen Mr. Dunham fully concurs."

So far from the statements of the writer being correct, that "the failure of a cog, or the jamming of a pebble, might, under certain circumstances, be the means of ruining a ship," the experience of the past eighteen months has proved the contrary, and the "profound ignorance" of the assertion will be appreciated, when it is generally known that the turning-gates are never opened nor closed, except when the dock *is filled with water sufficient to float the vessel that may be coming into or going out of it*; and that if the contingency hinted at should ever occur, the outside floating-gate could be used while the obstruction was being removed. The same objection to the jamming of a pebble holds good, if the bottom rollers were moved by capstans, instead of the machinery now used.

I will add a few extracts from the article that appeared as original in the "Dictionary of Mechanics," now said to have been prepared by Mr. McAlpine, and show how very *improbable it is* that it could have been written by that gentleman. On pages 401, 2, 3, and 7 of that work, it is stated that "Mr. McAlpine was induced *to arrange a gate, made of wrought-iron, on an entirely original plan*," and that "*they are made as follows*."

"The gates and caisson *were designed* by *Mr. McAlpine*, and *constructed* by H. R. Dunham, at the Archimedes Works, New York."

"The engine and pumps *were designed by Mr. McAlpine*, and *constructed* by Messrs. Kemble, at the West Point Foundry."

"The engine-house *is* of fine cast granite, 300 feet long, 60 feet wide, and three stories high. The part *not occupied* for the *engines* and *pumps* is to be used for a machine shop for repairs."

"It is estimated that the sum of $420,000 will be required to *finish* this work."

In justice to my immediate predecessor, I cannot believe that he could have "*prepared or written*" the foregoing quotations, taken from the Dictionary of January, 1850, because he must have known they were *untrue* in almost every particular, as will be seen by the following extracts from the "Naval Dry Docks," and the accompanying copy of a letter from himself to Mr. Dixon, of July, 1849:

1st. As to the turning-gates and caisson of the dock. On pages from 33 to 38 both inclusive, it is stated that, "in a report made to the Bureau of Yards and Docks, the 1st of October, 1849, by the late engineer of the dock (Mr. McAlpine), he states that a contract was made, September 25, 1848, with F. C. Parsons, for the delivery of the *timber* for the turning-gates, on or before the 1st of July, 1849. * * *

"My attention was called to the necessity of providing a substitute, in the event of a failure to procure the timber. * * *

"An examination of the subject suggested the propriety of substituting iron for wood. * * *

"*Plans were prepared*, says Mr. McAlpine, for a gate made wholly of wrought-iron, except the quoin posts."

"These gates were *commenced* in the *spring* of 1850, and completed, ready for successful operation, the *last of August, eighteen hundred and fifty-one*." Also on page 65, the following: "John Dunham, Esq., had the personal superintendence of the contractor's work, and contributed many valuable suggestions respecting the details of this construction. Much credit is also justly due to Horatio Dixon, Esq., the experienced mechanical engineer, who was appointed by the engineer of the dock inspector of these gates, and, under the direction of the engineer, made the *original plans* for their *construction*, and subsequently added many improvements of his own invention."

2d. The pumping-engine and pumps.

In a report made by the engineer to the bureau, in 1849, he says: "After carefully examining the subject, I had *plans* and *specifications prepared* for a condensing vertical beam-engine, with a cylinder of 50 inches diameter and 14 feet length of stroke, and *four* lifting pumps, each of 50 inches diameter, two of ten feet lift, and two of six feet lift, which I had the honor to submit to you on the 24th of January last. These plans and specifications, and the whole subject, were referred to a board, composed of Charles W. Copeland, a steam engineer in the naval service, Wm. M. Ellis, engineer and machinist of the Navy Yard, Washington, and myself. This board was in session from the 27th February to the 21st March, 1849, discussing and examining the matter. Mr. Copeland strongly advocated a double-engine working at right angles, but in all other respects essentially the same as the plan submitted. A majority of the board (Mr. Copeland dissenting) adopted the plan of engine I had previously recommended to the department, and the same kind of pumps, but only *two* in number. The engine and pumps were advertised by the departments to be contracted in March last, and were contracted by G. Kemble, of Cold Spring, New York, in May last, to be completed by 1st January, 1850. I am unable to say what progress has been made in this work, because it has not been placed under my direction, but has been superintended by Mr. Copeland."

"Owing to the expenditure of the appropriation made in 1849 for this work, before the engines and pumps were very far advanced, and to very many important alterations from, and additions to, the original or contract plan and specifications during their construction, they *were not completed, ready for use, until the 16th January, eighteen hundred and fifty-one.*

On page 56 it is stated, that "to the engineer (Mr. Rumph, of the Cold Spring Foundry) most of the credit is due for the many *important additions and improvements that were made in the arrangement and construction of the pumping-engine and pumps*, differing very materially from the original plans furnished by the commission appointed by the department."

3d. The engine-house.

The foundations of the engine-house were commenced in the spring of 1849, and completed to the *level of the water table* in December of that year. The corner-stone of the water table was laid in April, 1850, and the walls of the east wing (where the engine and pumps are located) carried up in the summer of 1850; and the whole building inclosed by the 1st of August, 1851; and the cut granite now in the walls of this structure was not in the Navy Yard, January, 1850.

(Copy.)

DRY DOCK OFFICE, U. S. NAVY YARD,
Brooklyn, July 23, 1849.

SIRS—Mr. Horatio Dixon has been employed as a machinist and draughtsman on this work for several years past. He is an excellent mechanic, and has designed and drawn out a number of machines, for the use of this work, in a very skilful manner.

Among these are our pumping-engine, 50 inches diameter, 12 feet stroke; pumps, 63 inches diameter, 10 feet stroke; the massive iron gates and caisson (the only ones in America), and various other lesser machines.

Mr. Dixon is decidedly ingenious; and though unable to explain his ideas in words, will project them on paper, and execute them in a very satisfactory manner.

I learn from him that you desire a foreman, and I have no doubt but you will, if you employ him, be as well pleased as I have been.

Respectfully your obedient servant,
WM. J. McALPINE, Engineer.

Messrs. Merrick & Towne, Philadelphia.

It will be evident, from the foregoing *official* statements of Mr. McAlpine, together with his letter to Mr. Dixon, that, as before remarked, he could not have been the author of the article in Appletons' Dictionary, credited to him by the writer of the article in your magazine, as he must have been perfectly aware of the condition of the work when he left it, and the incorrectness of the statements in reference to the completion of the important structures therein named. It is a mistaken friendship for this gentleman which induces the writer to claim for him what he could not have claimed for himself, and certainly did not do.

Having thus shown the injustice done to Mr. Dixon, and the correctness of the statements in relation to him in my work, I may be permitted to make a further addition to this notice, already too far extended upon matters personal to myself.

When I commenced this history, it was with a desire to show to our own countrymen, and to others in foreign lands, in a permanent form, some of the triumphs of American engineering. My object was a national one, and the first quotation made in this "review" shows that this purpose has been obtained. It was also my intention to exercise great care in giving to my several predecessors on the New York Dry Dock the credit due to them for their important share in this great structure, and especially to the one whom I immediately succeeded. If a foreign editor, hastily reading the work, imbibes the impression that I planned the dock, the gates, engine, &c., and built them all, certainly I should not be held responsible for his error, because my work *distinctly states, and this in its most prominent portions*, the names of the several superintending engineers, the dates of their charge, and of the various skilful operations, and gives a corrected detail synopsis of the actual work done, and amount of money expended under each. What I state in reference to the work done under my own charge, as well as that of my predecessors, is a matter of official record, and cannot be disproved.

To refute the statement on the subject of "authorship," that the language of the history is taken from "Appletons' Dictionary of Mechanics," it is only necessary to refer to the preface of the volume, where it is remarked that "care has been taken to refer constantly to the official records of the Navy Department, and the reports of the engineers in charge of the several docks during their construction, for valuable and reliable information;" and it will be seen not only that these reports have been used, but that particular credit is given to their respective authors. Whenever, therefore, the language of my history is found to coincide with that of Appletons' Dictionary, it is because both (together with an article in the "Tribune" of July 6, 1849) are taken from the same source—the difference consisting in the fact, that what I claim to have copied, the Dictionary published as original. The impropriety of statements farther made in that work I have already shown, as far as is important at this time.

The charge that my description of the Balance and Sectional Dry Docks was published in "Weale's Quarterly Papers" "over three years ago" (it was in 1845) is totally untrue, for the docks therein described have all been *designed, put under contract*, and *built* since the publication of the New York City Docks was made in Weale's papers. The basin and railway and hydraulic cylinder described in my work, and which are among the most prominent features of these docks, were not known at the time of Weale's publication, nor for several years thereafter, and occupy a large space of the second part of the volume.

With regard to the time and manner of my appointment to the charge of the New York dock, the writer is, as usual, singularly in error in stating that Mr. McAlpine was removed, and myself appointed, by President Fillmore. I was placed in charge of the work the 1st of October, 1849, *nine* months before the lamented death of Gen. Taylor.

CHARLES B. STUART.

New York, January 15, 1853.

Monthly Notes.

LAST FAST PRESS.—Messrs. R. Hoe & Co. have lately constructed a press with eight cylinders, designed for the Philadelphia Ledger. It has been put in operation experimentally, and made between 21,000 and 22,000 impressions per hour. This is no faster than eight-cylinder presses already in operation have been repeatedly driven, but there are various minor improvements in this press, which will much facilitate rapid working.

CIRCULAR SAW FRAME.—It was announced a few weeks ago that an ingenious mechanic, Mr. George, of Nashua, N. H., had invented a machine by which a circular saw was run without an arbor, and in such a manner as to cut a board nearly the width of the saw. The announcement naturally excited much surprise; but the following from the *Nashua Telegraph* explains how the arrangement, although scarcely desirable, may yet be possible and practicable:

"We have seen the machine operate, and can tell the editor how it is done. His other inquiry is already answered. The saw which we saw operate is a foot in diameter, and cuts a board ten inches wide, and we will try to tell how the thing is done. The saw is placed horizontally, and upon two opposite edges lies tightly held between two iron wheels, or pulleys, covered with leather; then an iron plate passes across the centre upon the upper side of the saw, in which a pivot, attached to the upper side, runs. This keeps the saw steadily in its place, while the under side of the saw presents a clear surface from the pulleys upon one edge to those upon the other. Motion is applied to these pulleys, and those on the opposite sides of the saw moving in opposite directions; the saw is moved round rapidly, held in place, as before stated, by the pivot revolving in the plate across the centre. This plate is brought to an edge upon either side, so that, in sawing a board, it springs so as to pass over it. The log—for the machine is designed for sawing logs—is placed upon the carriage, which feeds itself, and as it progresses the board passes over the plate. When it has cut through, the board is removed, the log raised by a convenient operation, so as to cut another board, the motion reversed, and the carriage goes back again, cutting a board as it goes, and so on, until the log is all sawed up. The great advantage of the plan is the ability to saw large logs—a saw four feet in diameter sawing a board nearly its own width. The power being applied to the outer edge of the saw, it is obvious that the larger the saw, the greater the power, being increased in the same ratio that it is decreased in the old method. It may seem as if the pulleys which impart motion to the saw might be made to slip upon it, when any obstacle is placed against it. But we saw it demonstrated again and again, that while the pulleys run, the saw runs, and when an obstacle of sufficient force was applied to stop the saw, it stopped the pulleys and let a three-inch belt slip upon the shaft, the saw holding the pulleys fast. The machine is an ingenious one, and yet simple in its principles.

AUXILIARY SCREW NAVY.—The British *United Service Gazette* is severe upon the Lords of the Admiralty with regard to the expediency of their course in fitting engines and screws into the present ships of the line, instead of offering premiums for the best models, and constructing ships better adapted for propelling. It contends that the "Duke of Wellington," "Royal George," and other cumbrous ships which are being fitted, at great expense, with engines of only from 400 to 600 horse-power, will be almost useless. Sailing ships of war being considered as antiquated arks, valuable only as curiosities, or, as in the case of the "Pennsylvania," a magnificent and almost new U. S. ship of 120 guns, now lying "bedridden" in sand and oysters at Norfolk, valued only as a ball-room for naval parties, the question is simply this: Shall the ancient and well-tried "wooden walls" be abandoned, and new screw steamers built, or shall the sterns merely be altered, making a kind of hybrid marine, combining, possibly, all the faults of both classes. The facts, aside from this *opinion* of the Gazette, seem to favor the alterations, several large ships, among which may be included the "Agamemnon," of 120 guns, having been fitted with engines and propellers with tolerable success. The opinion seems to obtain with some, that unless a ship have the most powerful engines, capable of driving her with great speed, and requiring a mountain of coal to suffice for a few days' steaming, she is necessarily useless lumber, which is far from being the case. Steam propulsion, only sufficient when required to give from four to six knots in a calm, is by no means despisable, and in many cases may be the means of deciding the fate of a battle. The English Admiralty seem, however, to have made some splendidly awkward ships by thus doctoring, among which may be reckoned the "Royal Albert," now building at the Woolwich dockyard, designed for a sailing vessel, and already 200 tons larger than any vessel ever built for the Royal navy. After successively adopting and discarding several plans, the latest is to launch the ship, take her to the east dock, and lengthen her 35 feet, to make room for engines of 1000 horse-power. She will then have a capacity of 4000 tons.

AERIAL NAVIGATION.—Mr. Rufus Porter announces that he "now believes that his æroport may be put in full operation in two or three weeks of mild, calm, and pleasant weather." He has discovered nothing to shake his confidence in the success of the experiment. The machine is one hundred and sixty feet long, to be propelled by steam-engines, and capable of carrying six persons, and travel forty miles an hour. We also learn from a card in the Washington papers that he proposes to construct another, to be 700 feet long, to carry 150 persons, and to travel ninety miles an hour. He says:—The large æroport is estimated to cost $15,000, in 3000 shares at five dollars each. And he rationally estimates that *at that speed*, the æroport will make the trip to either California or to Europe and back once a week; and that if 150 passengers shall pay $200 per passage each way, the proceeds would be $60,000 per week, which would be twenty dollars per week on each $5 share. Though Mr. Porter does not really expect that the shares will produce such enormous rates of profits, he does expect that the percentage of profits will far exceed that of any other enterprise ever projected.

THE ACCIDENT AT ANDOVER, ITS CAUSE.—Our readers are doubtless well aware of the general facts of the accident at Andover, resulting in the instant death of the son of the President elect. The axle appears to have broken near the centre, throwing the car off the track and down an embankment. The Lowell Courier states that machinists who were present think the defect must have been plainly in sight for many days! The axle is three inches in diameter; the thickness of an inch and a quarter in the centre was broken at the time of the accident, but the remainder, comprising much the greater portion of the iron, has the appearance of having been cracking around deeper and deeper for some time, so that while in any position the upper sides of the fracture came together and the bottom spread apart, thus straining the central portion until it gave way.

M. PETIN'S MOVEMENTS.—We know nothing of the skill of this enthusiastic æronaut, but his late experiments seem to be attended with a continual train of harmless accidents. The latest ascension, at New Orleans on Christmas Day, in a machine of enormous size, and accompanied by three friends, resulted in attaining an elevation of about 18,000 feet, or over three miles, "the balloon obeying the will of the pilot," until "by some derangement of the valves, too much gas escaped," and the party made a precipitate descent into Lake Borgne, and were rescued by means of a steamboat. The magnificent balloon, with its cork car and extensive wings, was much damaged, and nearly ruined.

THE ENGINES OF THE ERICSSON.—The engines in the ship "Ericsson" differ from the one in our plate principally in the fact, that the supply cylinders are raised above the working cylinders sufficiently to allow the beam to play between them. The beam connects to the under side of the supply pistons by links; the four cylinders are in line with the keel, forward and aft of the shaft, the rods from the two beams connecting to one central crank at right angles to each other, so that one is at half stroke when the other is on the dead point. The successful trial trip we hoped to record in this number has not yet transpired, owing to imperfections in the machinery. Her success has been announced as established in the daily papers, without any grounds further than excelling the steam-engine in the ratio of about 5 to 4. There are no contracts made for other caloric engines.

NEW LINE OF STEAMERS FROM FRANCE.—The late foreign news gives the outline of arrangement for a line of the largest-sized steamers, to run from French to American ports. The emperor's designs are, doubtless, similar to those of Louis Phillippe, who constructed a number ostensibly for a similar purpose, but ended by attaching them to his navy. The new Company is to be bound to construct thirty-eight (!) of the largest-sized steamers, capable of carrying an armament and 2000 men. The head-quarters is to be at Cherbourg, but a line is allowed from Goree or Lisbon, branching off to Marseilles.

To Readers and Correspondants.

WE invite attention to the queries in this number, and will publish answers in our next. The first, which appears almost ridiculously simple, points at the very foundation of the great disagreement between the College and the Workshop science, as applied to mechanical questions. "Machinist," whose "notes on the Ericsson" are alone worth a year's subscription, is the same who, in the last volume, answered the challenge questions on centrifugal forces and the Static Pressure Engine. We have received from Gen. Stuart a reply to the "Review of the Naval Dry Docks;" from J. K. F., a valuable article on Architectural Engineering; from W. R., on "Excavation and Embankment;" and a variety of books and other favors, from various sources, the consideration of which must be deferred to the next number.

H. F. S., of Pa.—It will be difficult for us to obtain the information from any source now available.

P. M. T., of Ga.—There is not the least indication, publicly, of any weakness or difficulty, and the work is progressing steadily. The stock has declined slightly, selling now for 145. The only claim ever made to superiority over the London Fair, was in the *usefulness* of the articles to be exhibited.

R. M., of Penn.—The flues of the Reindeer were of No. 4, and the connections of No. 2, iron. Don't know the kind of iron.

G. V., of Maine.—The length and speed of any wheel should, besides the usual considerations, be influenced by the cheapness of the water. Where water is plenty, a cheap wheel with short buckets may work with the same power as a larger and more expensive one, but it must consume more water. Many of the saw-mills on the Penobscot are still more wasteful of water than on the Kennebec; in fact, water-power on that river costs nothing, and the expense of a large slow wheel and geering might ruin them. Send us all the particulars, and we will give you the usual and most approved proportions.

S. H., of N. Y.—Mr. Nasmyth's improvements in forging were illustrated in vol. 1, pages 223 to 226. They were first made public, we think, before the British Association, in 1850, and were highly approved by that body, but we are not aware of their result in practice.

G. B., of N. Brunswick.—The dissolving power of the gastric juice has been much over-rated, particularly with regard to the powers of certain species in this respect. The ostrich has, certainly, little discrimination in its diet, but its powers of digestion are quite limited, and it is a popular mistake that it dissolves the pebbles, &c., which it swallows. The African ostrich, in the American Museum in this city, can dissolve chestnut-shells, and this is about the extent of his powers. The finest ostrich in the Zoological Gardens, at London, died in consequence of snatching the top from an umbrella and swallowing it. Please let us have the results of your experiments.

J. P., Penn.—We have not at hand the dimensions of the Princeton's boilers, but you will find a full description (with plate) of that style of boilers on page 170 of our last volume, under the title of Lamb's Marine Boiler. We know nothing of the circumstances inducing the adoption of these boilers by the Peninsular and Oriental Company. Mr. Lamb is, we think, the President of that Company.

H. S. F., Penn.—Yours shall receive attention.

APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 3.—Vol. III.—MARCH 1st, 1853.

STEAM LOG OF THE STEAMSHIP "ARCTIC,"

*Belonging to the Collins Line of U. S. Mail Steamers between New York and Liverpool.**

BY B. F. ISHERWOOD, CHIEF ENGINEER, U. S. NAVY.

By the kindness of chief engineer Daniel B. Martin, U. S. Navy, I have obtained copies of the steam logs of the Arctic for the time he was chief engineer of her. . . . It is believed that the data and results here presented are as near the truth as it is possible to approximate, and even much nearer than is required for any practical purposes. It is possible that the dimensions of the hull may not be accurate to an inch, but I believe them to be correct.

Hull.—Length on deck,	284 feet.
Length between perpendiculars,	280 "
Beam on deck, extreme,	46 "
Depth below main deck,	24 "
Depth below spar deck,	32 "
Burden,	2878 tons.
Mean draft of water on leaving port,	20 feet 8 inches.
" " arriving at port,	17 " 6 "
Average draft for the voyage,	19 "
Immersed amidship section at 19 feet draft,	685 square feet.
Displacement at 19 feet draft,	3724 tons.
" 17 feet 6 inches draft,	3368 "
" per inch of draft at 19 feet draft,	22 "
" " " 17 feet 6 inches draft,	204 "
Angle of entrance at load line,	36°
" " launching line (forward, 8 feet 11 inches; aft, 10 feet 5 inches),	26°
" clearance at load line,	25°
" " launching line,	22°
Weight of the hull,	1880 tons.

The hull is braced by iron bars 45 feet long, and 6 inches by 1 inch in section, placed 4 feet from centre to centre. The bars run in both directions, and cross at an angle of 45°; at each crossing they are riveted together.

Engines.—Two side-lever condensing engines.

Diameter of cylinders,	95 inches.
Stroke of pistons,	10 feet.
Space displacement of both pistons per stroke,	984·48 cubic feet.

Paddle Wheels.—Of the common radial kind.

Diameter from outside to outside of paddles,	34 feet 5 inches.
Length of paddle,	11 " 6 "
Width,	21½ "
Immersion of lower edge of paddle at 19 feet draft,	6 " 6 "
Number of paddles in one wheel,	36
" " in water in one wheel,	10
Area of two paddles,	41·208 sq. feet.
Area of all immersed paddle surface,	412·08 "
Proportion of the area of two paddles to area of immersed amidship section of hull,	1·000 to 16·628.
Proportion of the area of all immersed paddle surface to area of immersed amidship section of hull,	1·000 to 1·662.

Boilers.—Four iron boilers, with vertical tubes. The water is contained within, and the fire is applied without, the tubes. The boilers are placed in pairs, back to back, with one smoke chimney in common. Each pair has its own fire-room. The forward and after pair are alike, except in breadth and number of tubes; each forward boiler being 14 feet broad, and containing 1332 tubes; and each after boiler being 15 feet broad, and containing 1480 tubes; making a total of 5624 tubes in the four boilers. These tubes are of iron, and two inches in external diameter; 2812 are five feet long, and 2812 are four feet six inches long. Distance in clear between tubes lengthways the boiler, 0·944 inch; crossways the boilers, 1·591 inch.

Length of each boiler,	20 ft. 7 in.
Breadth of each forward boiler,	14 "
" " after "	15 "
Height of each boiler, exclusive of steam chimney,	13 " 8 "
Area of heating surface in furnaces of two forward boilers,	1204 sq. ft.
" " tubes "	7328 "
" " tube boxes "	500 "
" " smoke connections "	263 "
" " furnaces of two after boilers,	1242 "
" " tubes "	8137 "
" " tube boxes "	533 "
" " smoke connections "	277 "
Total heating surface in the four boilers,	19,484 "
Area of grate surface in the two forward boilers,	279·555 "
" " after "	308·328 "
Total area of grate surface in the four boilers,	587·889 "
Aggregate cross area of the spaces between the tubes in the two forward boilers,	55·685 "
" " " " after boilers,	61·250 "
Total aggregate cross area of the spaces between the tubes in the four boilers,	116·935 "
Aggregate cross area beneath the hanging plate at back of boiler in the forward boilers,	83·000 "
" " " after boilers,	92·000 "
Total " " " four boilers,	175·000 "
Cross area of the smoke chimney,	78·540 "
Height of the smoke chimney above the grates,	75 feet.
Capacity of the steam room in the four boilers,	4850 cubic ft.
Weight of sea-water contained in 4 boilers, by calculation,	392,800 pounds.
Proportions.—Heating to grate surface,	33·142 to 1·000
Grate surface to aggregate cross area of spaces between tubes,	5·028 "
" " " beneath the hanging plate,	3·359 "
" to cross area of smoke chimney,	7·485 "

* * * * * * * * *

Summary of the Steam Log. From New York to Liverpool.

Voyage.	Date.	Totals.					Means.			
		Number of double strokes of piston made.	Time from dock to dock. Hours and minutes.		Coal consumed in tons of 2240 pounds.	Geographical miles run by observation.	Steam pressure in boilers per square inch above atmosphere in pounds.	Number of double strokes of piston made per min.	Coal consumed per hour in pounds.	Speed per hour in geographical miles.
7th.	December, 1851.	215016	278	15	958	3130	18·4	13·172	7812	11·455
8th.	February, 1852.	220066	282	41	866	3059	16·9	13·828	8337	13·146
9th.	March, "	231236	268	58	957	3088	17·1	14·609	8121	11·480
10th.	May, "	217740	245	32	920	3061	16·8	14·780	8393	12·556
11th.	June, "	211095	249	60	928	3092	15·1	14·150	8463	12·418
12th.	August, "	215477	258	15	949	3076	14·6	13·916	8231	11·911
	Means,	218748	263	47	928	3087	15·6	14·403	8199¼	12·194

From Liverpool to New York.

7th.	January, 1852.	241204	331	24	1050	3003	14·7	12·131	6962	9·893
8th.	Feb. & Mar. "	225152	283	44	1010	3058	16·6	13·226	7974	10·877
9th.	April, "	226178	279	08	946	3090	17·3	14·359	7582	11·024
10th.	May, "	222644	252	54	863	3069	16·9	14·672	7614	12·211
11th.	July, "	229920	268	18	975	3018	16·5	13·854	8124	11·249
12th.	August, "	228711	272	29	973	3061	14·6	13·968	7998	11·268
	Means,	226181	277	50¼	969¾	3073	16·1	13·653	7735⅞	11·189
	Means of Means,	222612	265	58	948 7/12	3080	15·85	14·028	7968	11·666

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* From the Journal of the Franklin Institute.

Remarks on the Steam Log.

An inspection of the preceding "summary," shows the voyages from New York to Liverpool to be on an average twenty-four hours and twelve minutes shorter than the average of the voyages from Liverpool to New York. The length of the route or distance run can be taken to be the same in both directions, the means by observation differing only fourteen miles, or less than half of one per cent. of the lesser distance; but the voyage from New York to Liverpool required on an average 7738 less revolutions of the wheels than the average voyage from Liverpool to New York. In the latter case, therefore, the slip of the wheels was 2·99 per cent. more than in the former; the slip in the latter case being 20·86 per cent., and in the former case 17·87 per cent. The consumption of coal also is less in the voyages from New York to Liverpool by an average of 31¼ tons; but the consumption of coal per hour is greater by 221½ pounds.

The difference in the performance of the vessel for the easterly and westerly passages, is probably caused by the greater prevalence of westerly winds. The distance from the Battery, New York, to Liverpool, by Mercator and great circle, is 3023 geographical miles; by Mercator, 3084 geographical miles. The mean, therefore, of 3080 miles, made by the Arctic, shows very excellent navigation.

Coal.—The coal used in the voyages from New York to Liverpool was the Pennsylvania anthracite; in the voyages from Liverpool to New York, the Welch coal of similar chemical composition.

Evaporation by the Pennsylvania Anthracite.—The cut-off used in the Arctic was Stillman & Allen's; it was adjustable, and frequently changed within short limits, as circumstances of weather, quality of fuel, &c., required; the object being to run with a *wide throttle* and maximum boiler pressure. The average point of cutting off was four feet four inches from the commencement of the stroke, and the steam space comprised between the cut-off valves and pistons of the two cylinders at one end, is, as near as I have been able to obtain it, 25 cubic feet, which I believe is exact. This would make the bulk of steam used in both engines per stroke 451·608 cubic feet. The number of double strokes of piston per minute was 14·403, making the bulk of steam used per minute 13009·02 cubic feet. To this must be added the loss by *blowing off* in sufficient quantities to maintain the sea-water in the boilers at 1¾ the natural concentration. From the data given in Regnault's experiments, this loss would be as follows—the temperature of the feed-water being maintained at 110° Fah., and the average steam pressure in the boilers being 15·6 pounds per square inch above atmosphere, or 30·3 pounds total pressure. The total heat of steam of this pressure is 1158·34° Fah., of which 110° were furnished by the feed, leaving 1048·34° to be furnished by the fuel to the three parts of the water evaporated. The temperature of steam of 30·3 pounds being 252·2° F., and the temperature of the feed 110° F., there was (252·2—110=) 142·2° F. to be supplied by the fuel to the four parts blown out; and

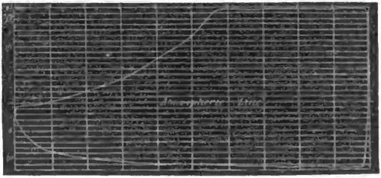
$$1048{\cdot}34 \times 3 = 3145{\cdot}02$$
$$142{\cdot}20 \times 4 = \ \ 568{\cdot}80$$

and 3713·82° equals total heat

supplied by fuel, of which 568·80° is 15·32 per cent., and is lost by *blowing out*, leaving 84·68 per cent. of the fuel utilized in evaporation, and if 84·68 per cent. evaporated 13009·02 cubic feet per hour, 100 per cent. would evaporate 15362·57 cubic feet. The mean of a large number of indicator diagrams gives the initial cylinder pressure two pounds less than the boiler pressure, making it 28·3 pounds per square inch, and the relative of bulks of steam of this pressure and the water from which it is generated is as 932 to 1: $\frac{15362{\cdot}57}{932} = 16{\cdot}4834$, which, taking the weight of distilled water at 62½ pounds per cubic foot, becomes 1030·2125 pounds of steam evaporated per minute, or 61812·75 pounds per hour by 8199½ pounds of coal, *which is* 7·539 *pounds of steam evaporated per hour from sea-water of one and three-fourths the natural concentration, by one pound of Pennsylvania anthracite, with temperature of feed-water* 110° *F.*

Evaporation by the Welch Coal.—Proceeding in the same manner with the Welch coal, with the same point of cutting off, and the same difference of two pounds between the initial cylinder and boiler pressure, and making the necessary alterations for the different total and sensible heats of the slightly different steam pressure, there results *an evaporation of* 7·653 *pounds of steam per hour from sea-water of one and three-fourths the natural concentration, by one pound of Welch coal, with temperature of feed-water* 110° *F.*

The results from the Anthracite and Welch coals agreeing so very closely, it may be concluded the two fuels are of equal value as generators of steam, an agreement we should also be entitled to expect from their closely resembling chemical constitutions, which compare as follows—Professor Walter R. Johnson being the authority for the Anthracite, and the British Commission of De la Beche and Playfair for the Welch coals from the northern part of Wales:



	Pennsylvania Anthracite. Mean of 9 analyses made on coal from 6 localities.	Welch Coals. Mean of analyses made on coal from 14 localities.
Fixed carbon, ...	88·540	88·892
Volatile matter, including moisture,	5·170	7·279
Sulphur, ...	0·052	0·912
Earthy matter, ...	6·510	3·095
Total, ...	100·272	100·168
Pounds of steam evaporated by 1 lb. of coal, under similar circumstances, with same boilers, engineer, &c., being the mean results from a combustion of 5568 tons of Anthracite and 5755 tons of Welch coals, ...	7·539	7·658

Performance.—The mean performance of the Arctic for the six voyages eastwardly and the six voyages westwardly, being the average of 3190 hours and 38 minutes steaming, is as follows, viz.:

Speed of the vessel per hour in geographical miles of 6082⅔ feet,	11·666
" " " statute miles of 5280 feet,	13·439
Revolutions of the wheels per minute, ...	14·028
Slip of the centre of pressure of the paddles, ...	19·32 per cent.
Oblique action of the paddles, ...	21·50 "
Steam pressure in boilers per square inch above atmosphere,	15·65 pounds.
Initial steam pressure in cylinders per sq. in. " .	13·85 "
Point of cutting off from commencement of stroke, . .	4 feet 4 in.
Mean effective pressure per square inch of pistons, .	19 pounds.
Horses power developed by the engines, ...	2290
Consumption of coal per hour, ...	7978 pounds.
Consumption of coal per 24 hours, in tons of 2240 lbs., .	85·48 tons.
Consumption of coal per sq. ft. of grate surface per hour,	13·571 p'nds.

Indicator Diagram.—The accompanying indicator diagram is selected from a large number, to show the average performance of the engines, setting of the valves, &c. It was taken from the top of the starboard cylinder, the engines making 14¼ double strokes of piston per minute. Steam pressure in boilers above atmosphere. 18½ pounds per square inch. Temperature of hot-well 113° Fah. Throttle wide.

Stirling's Air-Engine.

THE following old invention and discussion is presented *because* it is old, for which reason it has never met the notice of many of the younger and more active of our readers, and has been allowed to escape the memory of others. Mr. Robert Stirling, a Presbyterian clergyman in Scotland, and an amateur in mechanical matters, made an engine the subject of a patent dated Oct. 1, 1840, which was described before the Institution of Civil Engineers, in 1846, by his brother, John Stirling. We present the description by Mr. S., and the discussion which ensued, as it appeared in the English mechanical magazines at the time. It will be seen that the Ericsson engine is but a slight advance on the engine of Stirling, the principal features being substantially the same in each: Stirling used the same air, as well as the same heat, over and over, while Ericsson takes fresh air every stroke. By the latter arrangement, cold air is obtained for the pump without taking trouble to cool the air of the exhaust for that purpose, but it involves the necessity of continually compressing a fresh quantity, a loss which can be but imperfectly compensated for by allowing the air to act expansively. Whether the gain or loss is greater in this arrangement has not yet been satisfactorily shown, either in theory or practice.

[From the London Mechanics' Magazine, 1846.]

The principle upon which the movements of this air-engine depend, is the well-known one in pneumatics, that air has its bulk or pressure increased when its temperature is raised, and diminished when its temperature is lowered.

Two strong air-tight vessels are connected with the opposite ends of a cylinder, in which a piston works in the usual manner. About four-fifths of the interior space in these vessels is occupied by two similar air-tight vessels or plungers, which are suspended to the opposite extremities of a beam, and capable of being alternately moved up and down to the extent of the remaining fifth. By the motion of these interior vessels, which are filled with non-conducting substances, the air to be operated upon is moved from one end of the exterior vessels to the other, and as one end is kept at a high temperature, and the other as cold as possible, when the air is brought to the hot end, it becomes heated and has its pressure increased, and when it is brought to the cold end, its heat and pressure are diminished. Now, as the interior vessels necessarily move in opposite directions, it follows, that the pressure of the inclosed air in the one vessel is increased, while that of the other is diminished. A difference of pressure is thus produced upon the opposite sides of the piston, which is thereby made to move from the one end of the cylinder to the other, and by continually reversing the motion of the suspended bodies or plungers, the greater pressure is successively thrown upon a different side, and a reciprocating motion of the piston is kept up. The piston is connected with a fly-wheel in any of the usual modes, and the plungers, by whose motion the air is heated and cooled, are moved in the same manner, and nearly at the same relative time with the valves of a steam-engine.

This description will be sufficient to show how motion and power are produced, and it is only necessary to add, that the power is greatly increased and made more economical by using somewhat highly compressed air, which is at first introduced, and is afterwards maintained, by the continual action of an air-pump. It may here be mentioned also, that the pump is employed in filling a separate magazine with compressed air, from which the engine can be at once charged to the working pressure.

If all the heat, however, which is necessary to raise the air to the required temperature, were to be thrown away or lost every time that the air is cooled, the power produced by its expansion and contraction would be much more expensive than that which is gained by the use of steam. In order, therefore, to understand how the work of a good steam-engine has been done, with about one-third of the fuel consumed by it, it is necessary to point out the method by which the greater part of the heat is preserved, and is used repeatedly, in expanding the air, before it is finally wasted or lost.

For this purpose, when it is necessary to cool the air, after it has been brought to its greatest heat, it is not at once brought into contact with the coldest part of the vessels. This would indeed effectually cool it, but the heat when thus extracted would be entirely lost, because it could never again be taken up by a body warmer than itself. Instead of this, therefore, the air is made to pass from the hot to the cold end of the air-vessel through a multitude of narrow passages, whose temperature is at first nearly as great as that of the hot air, but gradually declines till it becomes nearly as low as the coldest part of the air-vessel. Now, as every body by contact will give out heat to one that is colder than itself, the air, when it enters the narrow passages, must give out a portion of its heat, even to the hottest part of these passages, and must continue in its progress to give out more and more, as the temperature of the passages is diminished, till at last when it is ready to escape into the cold part of the vessel, there is only a small portion of the heat to be extracted, in order to bring it to the lowest temperature required. By far the greater part of the heat, therefore, has been left behind, in the metal which forms the passages, and which is so contrived and arranged, as to retain that heat until it is again required for heating the air. It must be evident also, from the manner in which the heat has been distributed, or spread out, over the whole length of those passages, that it is capable of being again employed in heating and expanding the air; for when the cold air is again made to enter the passages for the purpose of being heated, it immediately comes into contact with matter that is hotter than itself, and consequently begins to acquire heat, even at its first entrance, and as it is successively applied to surfaces of a greater temperature, it continues to receive more and more heat, so that when it comes at last to the hot end of the vessel, it requires but a small addition to its temperature to give it the elasticity which is necessary to move the piston. Thus, instead of being obliged to supply, at every stroke of the engine, as much heat as would be sufficient to raise the air from its lowest to its highest temperature, it is necessary to furnish only as much as will heat it the same number of degrees, by which the hottest part of the air-vessel exceeds the hottest part of the intermediate passages.

This arrangement or contrivance for the heating and cooling of air and other fluids, which may be termed the economical process, forms the foundation of all the success which has been attained in producing power, with a small expenditure of fuel.

This principle was devised and acted upon by Mr. R. Stirling nearly thirty years ago, but until the present time it could not be said to have been beneficially applied to the production of power. The several means by which the principle is at last rendered effective, consist, chiefly, in the employment of various means for keeping the piston-rods air-tight, and enabling the pressure of the air to be raised, to such an extent as to bring the engine into a small compass, and in the introduction of an effective refrigerating apparatus for extracting the waste heat and bringing the air to a lower temperature than could otherwise have been attained.

The greatest difficulty which was encountered, consisted in the proper application of the heat to the outside of the air-vessels. When applied directly by radiation from the fire to the spherical bottom of the vessels, it necessarily heated one part too much and another part too little, and the overheated part was not only liable to rapid oxidation, but by its expansion the other parts were strained and cracked. The heat is now applied chiefly by means of the hot-air which passes through the furnace; and it is found that, instead of requiring more fuel to keep up the heat, by this method it is accomplished with a considerable less quantity. It is found also that when the flues for distributing the heat over the surface are properly constructed, the air-vessels are very equally heated, and neither show a hurtful tendency to oxidation, nor to that unequal expansion by which the air-vessels might be destroyed.

The first engine of this kind which, after various modifications, was efficiently constructed and heated, had a cylinder of 12 inches in diameter, with a length of stroke of 2 feet, and made 40 strokes or revolutions in a minute. This engine moved all the machinery at the Dundee Foundry Company's works for eight or ten months, and was previously ascertained to be capable of raising 700,000 lbs. one foot in a minute. Finding this power to be too small for their works, the Dundee Foundry Company erected their present engine, with a cylinder of 16 inches in diameter, a stroke of 4 feet, and making 28 strokes in a minute. This engine has now been in continual operation for upwards of two years, and has not only performed the work of the foundry in the most satisfactory manner, but has been tested (by a friction brake on a third mover) to the extent of lifting nearly 1,500,000 lbs. It was found difficult to keep this load steadily applied for any length of time, owing to the strap becoming heated; but the engine has been worked for a whole day with a measured burden of 1,250,000 lbs., besides driving three extensive lines of shafting 370 feet in length; and this work it performed with an expenditure of 1000 lbs. of Scotch Chew coals, including the quantity necessary to raise the heat in the morning, and to maintain it during the two hours for meals, when the work was usually stopped. The coals used in this case were of inferior quality, and at least one-fourth less capable of producing heat than ordinary English coals. Taking this into account, and deducting 150 lbs., the quantity which was ascertained to be necessary for raising the heat in the morning, leaves a consumption of 600 lbs. in 12 hours. But little has yet been done in improving the furnaces, the principal attention having hitherto been devoted to ascertain the best method of heating the air-vessels, without regard to the economy of fuel. This result, although not so favorable as might be expected, is given to show the early capabilities of the engine. This engine requires only about a cubic inch of oil to keep the piston and rod in order for two days, and, in consequence of this, the friction of the cylinder and piston is decidedly less than it is in a steam-engine. In like manner the valves of the air-pump and safety-valves being free from moisture, do not show any tendency to get out of order. The leather collars also are very durable, that of the piston-rod usually lasting about three months, and the others six or nine months; and upon the whole, the working of the machine, besides the saving of fuel, is altogether more economical and less troublesome than that of a steam-engine.

It has been already stated, that the air is worked at a high pressure, sometimes rising at its maximum to 16 atmospheres, and it may perhaps be thought by those who have attended to the many accidents that are perpetually occurring from the use of high-pressure steam-engines, that the employment of the air-engine must be dangerous. A little consideration of the subject, however, will be sufficient to quiet all such apprehensions, and to show that there is less liability to explosion than in steam-engines of almost any description.

In the case of a steam-boiler, it is well known that a small addition of temperature gives a vast addition to the elastic force of its contents, and consequently when the safety-valve fails to act, if the application of heat be continued for a very short time, the internal pressure is increased to an immense amount. Besides, when an explosion takes place in a steam-boiler, there is not only a great quantity of steam already formed, which expands and spreads destruction around, but a large portion of the water, when the pressure is removed, flies up in the form of steam, and greatly extends the devastation.

In the air-engine, on the contrary, it is next to an impossibility to produce an explosion. The furnace must be so constructed for the safety of the air-vessels, that no great change in their temperature can be suddenly brought about, while it requires a great addition to the temperature of the air to make any considerable addition to its pressure. On the other hand, the forcing in of air by the air-pump is a very slow process, and as it is always adjusted so as to supply no more air than is sufficient to keep up the desired pressure, whenever a little addition is made to that pressure, it increases the unavoidable leakage to such a degree, that the further accumulation of air inevitably ceases. And while on these accounts it is not possible to increase the pressure of the air to the extent of one-fourth, the vessels are proved to the extent of double the maximum pressure, and are calculated to resist three or four times as much. Nay, even if such a thing as an explosion were to take place, it could not be attended with the disastrous consequences which attend the bursting of a steam-boiler, since the air, though allowed to expand to the utmost, would not amount to more than 20 or 25 times the bulk of the cylinder; indeed, in the early experiments, such innocuous explosions were more than once witnessed.

Besides, almost all explosions of steam-engines take place when the machine is at rest, while the air-engine, by the very act of stopping, has its maximum immediately reduced to the mean pressure, which is afterwards further diminished by leakage, and it cannot be again brought up unless by the slow operation of the air-pump, or the deliberate act of the engineer in letting in more air from the magazine, in which he is always guided by an indicator.

It may be supposed, that though the air-engine has worked well when placed under the inspection of experienced engineers, it will be liable to get out of order, or to become altogether unmanageable, when committed to the care of an ordinary fireman. But although, for the inventor's satisfaction, a skilful mechanic was kept in attendance for a considerable number of months, in order that every possible contingency might be observed and provided for, the engine is now committed to the charge of the same person who used to keep the steam-engine, and it is found to be equally simple and easy in its management, and sure and steady in its operation.

After the statement of these facts and explanations, it is not surprising that sanguine hopes should be entertained of the air-engine's coming speedily into general use as a moving power. It has already been successful to such an extent as to afford a powerful inducement to the use of it, wherever fuel is a matter of serious consideration. Even where the price of coals is lowest, the saving that would be accomplished by converting a steam-engine into an air-engine, would afford a fair return for the expense of conversion—much more profitable then must it be, when a moving power is required for a new establishment; but where the price of coals reaches, as it does in many parts of the world, to 20s. per ton or upwards, it would seem to be a matter of unquestionable propriety to make use of a power that can be maintained at about one-third of the present expense.

It would be needless, in its present state, to speculate on the probable results of the introduction of this engine for marine purposes. There every ton of fuel that is saved is not only a direct gain to the extent of its market price, but in long voyages an indirect gain is effected of at least twice as much more, from the increased accommodation which it allows for the carriage of merchandise. Nay, when the value of time is so well understood as at present, or when the rapid communication of intelligence is a matter of such importance, surely no slight objection ought to prevent the employment of any means by which a ship may be enabled to hold on her course without interruption, for twice or thrice the length of time she now does.

Many other improvements in the construction of the engine have suggested themselves during its progress, but which the serious expense of alterations has alone hitherto prevented the author from putting to the test—such as the introduction of valves, for relieving the working parts of the engine from the pressure during the time the crank is passing the centres, &c.; but the hope of the perfect success of the engine, and particularly to its successful application to the propelling of ships, is principally founded on the fact that the powers of the economical process, which theoretically appear to be infinite, are not yet practically nearly exhausted.

It was perceived from the beginning, that in order to render the heating and cooling of the air complete and economical, it would be necessary to make the passages through which it is conveyed from the one end of the air-vessels to the other, as narrow as possible. This is rendered necessary by the very defective conducting power of air, and the consequent difficulty of heating and cooling it. But on the other hand, the contraction of the passages, in which the air is heated and cooled, greatly increases the force which is necessary to pass it through them, so that, if they were made extremely narrow, the whole power of the engine might be consumed in transferring the air.

Elementary experiments could not be trusted, nor did there exist any theoretical calculations to determine the minimum width and length to which the passages might be reduced with advantage, and the proceedings have hitherto been by slow and cautious steps towards a practical determination of this problem. Each engine that has yet been constructed, has been improved by the contraction of its passages after a first trial, and there has been a decided improvement, both in power and economy, by these means.

There is no reason to believe that the maximum of effect, from the contraction and shortening of the passages, has yet been attained; and it may be expected, that the next engine that may be constructed, will be considerably improved in these particulars. A considerable increase, both in power and economy, may be anticipated from a more perfect application of the heat to the outside of the air-vessels—a matter in which the advances must be by still more slow and cautious steps.

In short, when it is considered how much has been already accomplished in what may be termed a first trial, and how much more is evidently possible, no doubt can be entertained that the air-engine will soon be adopted as a moving power.

The paper is illustrated by two drawings, and a working sectional model of the engine.

Minutes of Discussion on the Preceding Paper.

Mr. Stirling exhibited the model of the engine, and explained that the object was to raise the temperature of the air in the air-vessel, to such an extent as to obtain a difference of 500° between the heated and the cooled states. The air when heated might be taken at 650°, and after it had passed through the capillary passages, and the refrigerator, its temperature was 150°. The machine might be termed a differential engine, because the power was produced by the difference of pressure arising from the alternatives of temperature. At the first view its principle appeared somewhat paradoxical, because the thin metallic plates forming the capillary passages, by which the caloric was absorbed from the air, in its ascent, were used to give out the caloric to the air in its descent. The working pressure varied during each stroke from 160 lbs. to 240 lbs. per square inch. In order to understand the action of the engine, it must be remembered, that when the heated air came in contact with the lower end of the metallic laminæ forming the capillary passages, the absorption of caloric commenced, and went on gradually as it advanced towards the water-pipe refrigerator at the upper end, where a small portion of the heat, not previously extracted, was thrown off; and it must be evident that in the reverse action, when the air began to descend, it came into contact with the surfaces of the laminæ, from which it again absorbed the caloric, which had been left by the air in its ascent. A few degrees of heat, which had been conveyed away by the water in the refrigerator, required to be supplied at each stroke, and this was given by the heated air-vessel; thus keeping up its original temperature and pressure. When the air was in a heated state, the pressure was communicated to the piston, through the column of air, which constantly occupied the passages, and the air consequently reached the cylinder at a temperature not higher than 150°. The higher the pressure under which the engine was worked, the greater was the effect produced. A small engine on this principle had been worked to a pressure of 360 lbs. on the square inch. It might, eventually, be found more advantageous to work at a higher pressure, with a view to economy of fuel, as the friction did not appear to increase in proportion to the power exerted. It was found that the power derived from the pressure of the atmosphere (15 lbs. per square inch) was barely sufficient to overcome the friction of the engine. As the pressure augmented, so the practical effect was increased. It must be remembered also, that the pressure was sustained by an air force-pump, and that each air-vessel supplied itself, up to a certain pressure, by a self-acting valve. Any leakage was thus compensated.

If the connecting pipes and passages could be made infinitely small and short, the absolute power indicated by theory would be given out by the engine.

In answer to a question from Mr. Lowe, Mr. Stirling agreed, that Jeffrey's Respirator, used by consumptive patients, was based upon the same principle of the alternate absorption and giving out of caloric to air traversing the capillary passages.

Mr. Walker was at a loss to understand by what action the air was driven through the capillary passages; the rapidity of the alternate heating and cooling was equally extraordinary. From the statement in the paper it was evident, however, that a considerable power was advantageously obtained, by a small expenditure of fuel, which was the main point of interest for the institution.

Mr. Cottam said, it was evident that if it was practicable to arrive at the theoretical condition of the absorption of all the caloric by the thin laminæ, during the upward passage of the air and the giving it out again, during the downward passage there would not be any loss of heat. That, however, was not practicable, and as water was a bad absorbent, but a good conductor of heat, the difference carried off by the water in the pipes of the refrigerator, was necessarily the only loss.

Mr. Stirling explained that the air was set in motion by the alternate action of the plungers within the air-vessels.

With respect to the economy of the system, it must be premised, that some disadvantage resulted from the necessity of adhering to the length and number of strokes, fixed by those parts of the steam-engine which were retained. The consumption of fuel, as compared to the steam-engine, which the air-engine had replaced, was as 6 to 26; the same amount of work being now performed by about 6 cwt. of coals, which had formerly required about 26 cwt. The steam-engine which had been removed was not, however, of the best construction, nor had the boiler any close covering.

The average power required for the works had been ascertained to be equal to about 700,000 lbs. raised one foot high per minute, or 21 horses power. The quantity of water passed through the refrigerator was 4 cubic feet per minute, and the amount of heat communicated to it was 16° to 18°.

Mr. Gordon thought it was necessary to reject completely the idea of converting parts of a steam-engine into an air-engine; it should rather be an object to construct an engine which should communicate, by direct action, all the power derived from the pressure of the expanded air. The adhesion to the use of parts of a steam-engine had, in his opinion, increased the practical difficulties in the construction and working of the machine.

Mr. Stirling could not entirely accord with Mr. Gordon's views. It was true, that as he had before stated, the power had been restricted, by the obligation to use certain parts of the old engine; for instance, if it had been practicable to have increased the number of strokes, from 28 to 36 or 38 strokes per minute, the power would have been augmented nearly in proportion, or the same power could have been produced, from a machine of smaller dimensions. With respect to "direct action," if Mr. Stirling comprehended Mr. Gordon's meaning, there could not be any doubt, that a steam-engine would be a more economical machine than an air-engine, in which the air was merely introduced in a heated state, and was suffered to escape after producing motion. Such, however, was not the case in the machine under consideration; in it, the economy depended upon the reiterated use of the same air, alternately giving out and absorbing the same caloric. The principal practical difficulties of construction and use might be considered, in a great degree, as overcome, although, in further practice, many improvements would doubtless be introduced.

Mr. Homersham inquired, whether any indicator diagrams had ever been taken, from which the actual power exerted by the engine could be estimated.

Mr. Stirling replied, that some indicator diagrams had been taken, but he was doubtful whether they could be relied upon, as there was necessarily considerable friction in the instrument, owing to the necessity of rendering it air-tight by means of a leather cup. Besides, the indicator was affected, to a certain extent, by the motion of the piston, without reference to the expansion and contraction of the air, and the amount of that effect could not be correctly ascertained.

Mr. Field, V. P., could not understand by what means the commencement of the change of pressure was induced, so as first to generate motion in the engine, or to stop it, or reverse it, when in action.

Mr. Stirling explained, that motion was first induced by changing the position of the plunger by hand, in the same manner as the valves of a steam-engine were moved, and by the action of the eccentric rod the motion was continued; to stop, or to reverse the motion, the usual hand-geer was used.

Mr. R. Stephenson said, he understood the process to consist of heating the air in a vessel, whence it ascended to the cylinder between numerous thin laminæ, by which the caloric was absorbed, to be again given out to the descending air. Now it appeared to him, that though the ascending process was natural and easy, the reverse action would require a certain expenditure of power, in the depression of the plunger.

Mr. Stirling admitted, that a certain amount of power was necessary to move the plungers either way, and to overcome the friction of the air in the passages; but that no loss arose from any difference of pressure on the upper and lower ends of the plungers, that pressure being always equal, from the well-known principle of fluids pressing equally in all directions.

Mr. J. Smith (*Deanston*) corroborated the statements as to the efficiency of the engine; it worked very regularly and smoothly, and apparently with a considerable economy of fuel, which was supplied by a feeding apparatus, with regulating doors to the ash-pit, so that no waste of fuel occurred by the unnecessary introduction of cold air, either between the bars or through the fire-door, as was too frequently the case when the fuel was supplied by hand.

Mr. Leslie said, he had given much attention to the engine from its first introduction, and he was satisfied of its advantageous applicability in many cases; the engine under consideration had done a great deal of work very regularly, and with much economy of fuel; indeed the small dimensions of the fire-grate, which was only 24 inches by 22 inches, sufficed to show, that, except the fuel was carelessly used, only a very small quantity could be consumed. He directed attention to the differential lever for shortening or lengthening the stroke of the plungers, as more or less power was required; by a simple arrangement, this had been made self-acting, and was a very sensitive governor. He thought this might be advantageously adopted in steam-engines. It was extraordinary how very cool the cylinder was; it never became as hot as the cylinder of a steam-engine. He had noticed this particularly, because it had been imagined that the heated air would soon injure the cylinder and the piston.

Sir George Cayley was much gratified with the apparent success which had attended Mr. Stirling's efforts; he was particularly struck with the clever arrangement of the laminæ, and the refrigerating tubes, as by these means many of the difficulties he had encountered in his attempts to construct an air-engine were obviated. It was true, that his attention had been directed towards a different object, that of the production of a light locomotive engine for travelling on turnpike roads, for which purpose it had been his main object to reduce, as much as possible, the weight of the machine, and the number of the moving parts.

Acting upon the principle of air doubling its volume at a temperature of 480°, he had sought to produce motion by drawing air through the ignited fuel in the fire-box, and employing its expansive power at about 520°, directly upon a piston. In this process many difficulties were experienced, of which the principal were, the destruction of the slide-valve, the passages, the piston, and the cylinder, by the heat and the dust. The faces of the slide-valves were torn to pieces in a short time, and it became necessary to adopt a conical valve, which, although it in some degree avoided the great evil, was still considerably abraded. It was necessary to have an extremely well-fitting piston;

but, in a very short time, both it and the cylinder were much injured by the same action of the heat and dust. He had attempted to obviate this by appending a drum below the piston, and allowing a thin film of air around the periphery; but even that was not effectual. These were only a few of the difficulties he had to encounter in his experiments. The principal point of general interest was, however, the proportion of power obtained by Mr. Stirling from a given quantity of fuel. Sir. G. Cayley had not been so successful, as his engine consumed 6¾ lbs. of coke = 9 lbs. of coal per horse-power.

Mr. Stirling said, that his air-engine of 21 horses power consumed 50 lbs. of coal per hour, which was abont 2½ lbs. per horse-power per hour.

Mr. Gordon said, that in Mr. Stirling's engine, the intense heat of the fire did not come into actual contact with the piston; the motion was derived from the expansion of the air, caused by the heating of the air-vessel. Sir George Cayley, on the contrary, used the direct products of combustion, consisting of the expanded air and the gases evolved; and hence arose the difficulty of keeping in order the working parts of the engine. The difference between the two systems was, however, most apparent in the relative consumption of fuel of the two engines, which, as being the commercial value, was the point of great interest for the public. It must not be lost sight of, that in adopting the use of air as a prime mover, such distressing accidents as had frequently occurred recently from the explosion of boilers, would be in future entirely avoided.

Mr. Stirling felt all reasonable confidence in the ultimate success of the air-engine, as all the changes hitherto made had improved its action, and increased the economy of the fuel consumed. It must be remarked, that Sir George Cayley, in following an entirely different object, had overlooked the great leading principle of repeatedly using the same heat. Mr. Stirling was of opinion, that except on that principle, the air could not be economically used as a moving power; his hopes of ultimate success were, therefore, fixed upon the further improvement of the economizing and refrigerating processes, as had been previously explained. He would be glad to learn from Sir. G. Cayley how to overcome the difficulty of using a piston in a hot cylinder, as he would then be able materially to increase the effect of his engine by connecting the cylinder with the hot, instead of the cold end of the air-vessels. In the attempts which he had hitherto made for this purpose, he had always found the inconvenience so great as to induce him to return to the arrangement exhibited in the model. He had endeavored to protect the piston by joining it to a false piston filled with non-conducting substances; but hitherto he had not obtained that success he wished. Upon his present system he found, that after working for 2½ years, the piston was not perceptibly worn, and the cylinder had attained a very high polish. The laminæ were not perceptibly corroded, there was not any dust or dirt in the air-vessels, and the quantity of oil used in the cylinder and piston was, literally, not more than a thimbleful in three days.

Mr. Field, V. P., said, that Mr. Stirling appeared to have been successful in preventing the piston and cylinder from being injured by the heated air. He would inquire whether there was any difficulty in rendering tight the stuffing-boxes of the piston, and air-vessel rods; and also at what part of the machine the air was introduced to compensate for the leakage which did occur.

Mr. Stirling replied, that the temperature of the rods was so low, that by means of the leather collars employed, there was no difficulty in keeping the stuffing-boxes almost perfectly air-tight. The temperature of the rods, which was generally about 150°, did not appear to vary at any time above 8° or 10°. The leakage to be allowed for was, therefore, very slight; and although, for the sake of convenience, the air was admitted into the nosle of the cylinder, it was, in fact, of no importance, as far as the effect of the engine was concerned, at what point it was introduced.

Mr. Julius Jeffreys said, the construction of the respirator, which had been alluded to, was so well known, that he would only refer to the principles of its operation, which had a close analogy with that of the laminæ of Mr. Stirling's engine. The conducting power of metals had been, in both cases, used for alternately absorbing and giving out the caloric. He had found, that when the plates were so united as to form one continuous series, the result was less positive than when there was a separation between each, and he thought, that if the vertical laminæ of the air-engine had been divided into lengths, by some non-conducting medium, they would have been found more effective. When one end of a continuous bar or tube was inserted in a fire, by degrees the mass became heated in its entire length, much more rapidly than when it was divided into lengths by a non-conducting substance. He thought it would be found, that if the temperature of the first portion was raised, say to 450°, the next would be at a somewhat lower temperature, and so on seriatim, until the whole of the caloric was extracted, and that in the reversed action, the heat would be given out in the same degree. He therefore considered the separation of the plates as of great importance.

Mr. Stirling was glad to hear the principle so clearly explained. In an early patent he had specified the arrangement followed in the respirator, intending to use a series of perforated plates, or wire gauze. The principle of having each plate separate was theoretically correct, but in practice he had not found any great disadvantage from the conducting power of the continuous laminæ; while the positive advantage of their continuity was in other respects very apparent. It must be admitted that when the engine was at rest, the conducting power of the laminæ had a tendency to equalize their temperature throughout; but in a few minutes after it had been set in motion, the caloric seemed, by an apparent power of self-adjustment, to have been removed, and properly dispersed along the laminæ, so that the temperature of the upper part of the air-vessels was lowered to that point at which it remained permanently during the actual working of the engine. He had tried the effect of dividing the laminæ into five portions, but had not observed any beneficial result in the working of the engine; and therefore, after numerous experiments, he had reverted to the continuous laminæ, which had been brought before and explained to the meeting.

Engineering Science in Ancient Egypt.

The base of the Great Pyramid is a square of 764 feet. This measurement was taken by Mr. Jomard, on the side to the north, after digging down to the true base; and the total perpendicular height was also found by him to have been 479 feet. Since that period, Mr. Perring has given us the following dimensions from accurate measurement:

	ft.	in.
The former base,	764	0
The present do.	746	0
Perpendicular height,	450	9
Former inclined height,	611	0
Present do.	568	3
Perpendicular height by casing-stones,	480	9

The total area of the base was thirteen acres, one rood, twenty-two poles; and at present it covers twelve acres, three roods, and three poles. And supposing the rock to average eight feet in height only over the whole extent of base, after deducting the hollow passages and chambers, Mr. Perring calculates that the quantity of stone originally used amounted to 89,028,000 cubic feet, or about 6,848,000 tons.

The present quantity of masonry, supposing it solid, is about 82,111,000 cubic feet, or 6,316,000 tons; the space occupied by the chambers and passages being taken at 56,000 cubic feet. Dr. Clarke observes that the stone used was a gray limestone, and rather more compact than that called clunch, and that when it was struck with a hammer, it exhaled a fetid odor. Denon describes this pyramid to have had 208 courses in height.

The outside casing-stones were found at the bottom, in their original position, near the centre; they were quite perfect, and had been hewn to their required angle before they were built in, and appear to have been afterwards polished down to one uniform surface. They were cut to an angle of 51 deg. 50 min., and were in height four feet eleven inches. At the base they measured eight feet three inches, and on the inclined side six feet three inches. Where they were jointed, the cement which interposed was so remarkably fine a layer, that it was scarcely perceptible.

The outer stones of this pyramid are laid in regular courses, and we find them, as described by Herodotus, very strongly cemented together. This author also informs us how these immense blocks, some more than thirty feet in length, were raised. He says that after the first course was laid, machines, constructed of short timbers, were placed upon it, which hoisted from step to step the various blocks, as they were brought along the inclined plane.

Goguet has given the form of such a machine, which consists of a timber frame containing a fulcrum, to which a long lever could be applied, worked by many men at one time, and capable of raising weights far greater than any we find used here.

Each course being so much within that below, it formed a sort of stairs, so that such a machine as is now described could be readily applied, and would serve to raise the blocks from one step to the other.

Such is the manner, probably, adopted by these early engineers to pile one stone upon another; and, by the magnitude of the masses they constructed, they hoped to render their work immortal. They are as solid as they are immense; and all the means that could be found to render them so were adopted. No timber enters into their construction, and the stones used are of great dimensions, and always solidly bedded.

The granite was obtained from Syene, which is a district reaching from the island of Philæ, along the whole line of the cataracts; that of the finest quality is obtained on the banks of the river.

The beautiful pink or rose-colored granite, the syenite of the ancients, is very hard, and composed of large crystals, which receive an excellent polish. Two-thirds of the mass is rose-colored feldspath; sparkling mica and glassy quartz fill up the intermediate spaces, mixed with hornblende occasionally. Pliny sometimes designates obelisks made of this granite, as Thebaicus lapis, because it came from the region between Thebes and Syene.

Another granite, more resembling that of the ordinary kind, is found contiguous to it, with particles occasionally much coarser or finer. To these may be added the fine-grained granite; the gray with gray-colored feldspath; black and white granite, which has white feldspath with black flakes of mica, and oriental basalt; and a very dark kind, which is owing to the abundance of mica.

The sandstone quarries of Hadjar Selseleh furnished the chief part of the building stone for the temples. They are situated in the sandstone district, and, according to some, the stone resembles the grès de Fontainebleau. When first taken from the quarry it is easily worked, and may be obtained in lengths of thirty feet or more.

We find some quarries of great extent on the borders of the valley of the Nile. Limestone was generally employed in all the early buildings; and quarries, from whence large quantities were taken, may be seen at Massarah, where there are tablets remaining, cut in the time of Ames or Amasis, the leader of the eighteenth dynasty, who ascended the throne about 1500 years before Christ; and from these quarries all the compact magnesian limestone used in the construction of the pyramids of Gizeh was taken. There are other quarries at Tehneh, on the point of a hill, where is a thin deposit of crystallized carbonate of lime; numerous nautili are found imbedded in the limestone, some of which are more than six inches in diameter.

In examining these excavations, we obtain some knowledge of the early Egyptian practice of detaching masses of stone, and also a valuable lesson on the saving of both material and labor. To the Egyptians the difficulty of constructing a pyramid was scarcely more than the removal of stone from the quarry, and building it up in the manner in which it lay previous to its being detached from the original bed; the only difference was, that the top stones of the quarry became the foundation stones of the pyramid. They were taken away in layers, all of the same thickness, and built in courses; and as the work proceeded, the quarry might represent as many steps from bottom to top as the pyramid. The stone was sure to lie the right way of its bed; and it would be scarcely necessary to mark an oblong stone after it was detached; its depth being uniform with the others, would indicate sufficiently its true position.

The manner in which a quarry is worked is deserving of our attention. It was commenced by levelling the surface of the rock, and marking out a square area of sufficient dimensions to afford the quantity of stone required; around this was cut a deep trench; at parallel distances, seven or eight feet square, according to the size of the stones, other parallel trenches were made, and then similar lines at right angles, dividing the whole into as many squares. After this the blocks were cut to their required thickness. Layer after layer was thus removed, according to the depth of the quarry, or as long as it yielded good stone.

At other times, after the square was marked out on the top of the intended quarry, which was usually selected on the side of a hill, or where its face was perpendicular to the plain below, a horizontal trench was driven through the middle of the square, and then the masses of rock were detached on each side of this first groove; and as each layer was removed, new trenches were cut, until the whole assumed the character of a series of steps on each side of the centre, which rose from the bottom to the top of the quarry, resembling the form of a pyramid. The same machinery which lifted the stones from their beds or steps answered to elevate them to their new position.

Limestone continued in use for many years, after which a fine sandstone was employed, which was discovered to be of far greater durability. The quarries of Silsilis are extensive, and situated between Edfoo and Gebel Silsileh. From them most of the sandstone was obtained which was used in the Egyptian temples and other public buildings.

[From the London Mechanics' Magazine.]

Small Fire-arms and their Projectiles.

BY C. A. HOLDSTOCK, ESQ.

Four nations of Teutonic descent lately made a display of arms that deserves the most serious attention. Switzerland, Prussia, England, and the United States, showed the work of their gunmakers in producing the grooved barrel and its appendages. Another nation, chiefly of Celtic descent, attempted to emulate the rest. Let us pass some of their arms in review.

Switzerland adopts a small bore, and fires a conical projectile upon a low trajectory. The country that produced John and James Bernouilli abounds in clever mechanics and men of science, who understand the qualities essential to the rifle.

Fig. 1 represents a section of this rifle, of the actual size.

Fig. 1.

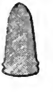


Fig. 2.

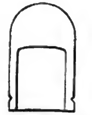
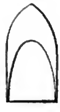


Fig. 3.



It is scarcely possible to imagine two systems more opposite than those now adopted by France and Prussia. France prefers the hollow, but Prussia fires the solid projectile. France gives but little attention to the exterior profile of the section. Prussia gives the utmost attention to the exterior profile, and depends on a shot that shall cut its way through the air, sustained by plenty of weight and solid lead. Each nation rejects the spherical figure, which confines its targets to a range of 300 or 400 yards. Each removes the targets to a range of 800 yards, or more, and strikes them with the new projectile. Yet it is found that the trajectories of these new projectiles rise to an elevation of 150 feet, or more, at long ranges. The air is seldom absolutely at rest, especially at such an elevation; and on windy days the rifle balls are frequently blown a yard or more from the mark, even at 300 yards' range upon a low trajectory. To expect much accuracy of fire on stormy days and upon lofty trajectories, at ranges of 800 or 1000 yards, would be expecting too much.

The riflemen of the United States have avoided the principal errors of the French, for the Americans are no novices in the study of the grooved barrel. Rejecting, of course, the spherical shot, they saw, as well as their predecessors, that the chamber may contain the charge of powder. Fig. 2 is a section of the projectile belonging to the American rifle, twenty-four of which can be fired in one minute by that gun. The powder in the chamber is confined by a thin cover of wood, with a hole in the centre. The barrel has two grooves, each three-fifths of an inch in width, and very shallow. This projectile is defective, and the head of the shot is sometimes blown right away from the rest, leaving the cylindrical part sticking in the barrel.

Another projectile of a similar class, but of improved section, is shown in Fig. 3.

Both these sections represent the actual size; but these chambers do not contain powder sufficient to command an extensive range; a defect which will be remedied.

The British two-grooved army rifle may be fired about twice in a minute; the Swiss rifle about twice in a minute; the Minié rifle about twice in a minute; the Prussian zundnadelgewehr six times in a minute; the new American rifle more than twenty times in a minute.

The problem of the geometrical figure that is due to a military projectile, has now received three distinct solutions, pointing to the conclusion that there is one general solution, embracing each of the three as a separate case. Each of the three results permits the targets to be set up at a range of 1000 yards, or more.

The imperfections of the Minié rifle and of its projectiles, are well known to every accomplished rifleman in this country; and experience in actual service will assist the two governments in learning what those defects are. Sir Howard Douglas properly observes on this point, that "It behooves us to be very cautious not to be led to prefer these foreign arms to our own for general service."

In a paper which appeared in the *Mechanics' Magazine* in the year 1843, I referred to the solids generated by permitting melted lead to fall through resisting media. Though I had previously explained these views to Professor Christie, and the most distinguished members of the Board of Ordnance, they did not appear to appreciate, or to understand, the importance of the subject, and, with the exception of a few accomplished civilians, it was not regarded in this country. On the Continent, the education of military men is a matter of extreme importance, and every thing published in England that can possibly conduce to that object is immediately translated and carefully considered. In Prussia, the officers who in their youth had followed the Prince Field-Marshal Von Blucher, are now as energetic in the cabinet as they were then in the field.

They attacked the problem of missiles as they would have attacked any other difficulty, and proved that they had conquered it by slaying some thousands of their enemies with a projectile of this class, fired from the zundnädelgewehr. At page 337 of the "Treatise on Naval Gunnery," by General Sir Howard Douglas, is an engraving of this weapon with its projectile.

The figure of the latter may be produced by carefully pouring melted lead into water.

The four-grooved rifle has been in common use in England for many years. The projectile described as "cylindro-conical," has been known to London gunmakers for nearly half a century. The writings and the experiments of Captain Norton, the inventor of the rifle-shell, had shown many years ago what might be done with expanding shot, and the two-grooved barrel could throw projectiles that struck the target at a range of 1200 yards.

In the exercise of my profession, I have been engaged in the education of officers, and have been led to observe that an artillery officer is placed under a disadvantage in finding that his attention is chiefly directed to smooth-bored guns, and thus taken away from the construction and qualifications of grooved barrels. The brave and skilful, but unfortunate, general who commanded the armies of France from the beginning of the present century until the year 1815, had received the education of an artillery officer; and not appreciating the grooved barrel, he expelled all rifles from the armies under his command. In vain did he lose his officers by hundreds in Spain and Germany; in vain did he hear of the destructive "boulets d'officier," and acknowledge their fatal effects. No experience could remove his prejudice in favor of the smooth bore, or his ignorance of the rifle. To the end of his career he persisted in his exclusive devotion to smooth-bored guns.

Having reduced the French army to a condition, on the most important subjects in gunnery, that can only be regarded with surprise, the troops were left to make the best they could of this depressed state of military knowledge. A few years after his death, a French army was ordered to Africa, and there they acquired from the Arabs much valuable knowledge on this subject.

The superior knowledge of the Arabs was only too evident, and the French officers began to study those principles of gunnery which forty years of erroneous practice had rendered obsolete among them. Their officers, too, were able to obtain translations of all that had been published in Europe, and could find means of learning what was practically known on the subject in other countries. With this information to aid them, the French could not avoid improving, and their improvement is very creditable to them.

◆

Iron-Founders' Casting Ladles.

[From the Glasgow Practical Mechanic.]

From frequent conversation with my fellow-workmen, and others conversant with the trade, I am fully persuaded that a general opinion prevails, that if a ladle is geered there is nothing to fear—an opinion which, on more than one occasion, my experience has proved to be incorrect; and from the fact, that great mechanical power can be obtained by the screw and wheel, there is very little regard paid to the resistance it has to overcome, and as little to the size and proportions of the machinery.

From what I can learn of the sizes in use, it appears to me highly probable that many are strained far beyond the limit of safety, though they, for a time, may not break. It is also apparent to me, that many persons who are intrusted with the making or geering a ladle, have not leisure or inclination to investigate the subject, but content themselves with working it by "rule of thumb," or copying, with modifications, those they have seen. Such being my views, and believing that nothing has been published on the subject, I hope I may be allowed to offer the results of many experiments made in 1843–'44, at which time I imagined I was the first who had applied the motion, with a view of obtaining data on which to construct and manufacture the apparatus. I subsequently learned that I had been forestalled. The ladles employed in the experiments in question were cylindrical, the depth being equal to the diameter; but others of the following shape and proportions were in all cases adopted in practice:

The top or mouth of the ladle is elliptical; the minor axis = 1; the major = 1·3; the bottom circular, its diameter = 1; and the depth of the ladle = 1. The right lines joining the circular bottom with the elliptical top or mouth form the figure of the ladle. The journals were fixed in such position that an equal amount of power was required to capsize, or to prevent the capsizing of the ladle. The position of the journals for the cylindrical ladle was found to be at ⅜ths of the ladle's depth from the top, and ⅝ths from the bottom; and for elliptical ladles, at half the depth. The empty ladles were balanced by counter-weights, so that their centres of gravity were brought in a line with the journals. Under these circumstances, I found that to adopt, as far as practicable, a uniform proportion, and to work with the ease, safety, and regularity I consider necessary, it required for all ladles up to 5 tons, the diameter of the screw-wheel to be ·8 of the ladle's diameter; the pitch, 1¼ inch, and the radius for the hand-wheel, or handle for the screw, 9 inches. For ladles from 5 to 12 tons, a wheel and screw for both journals, having the same proportions as the preceding; the two screws to be worked simultaneously. For ladles from 12 to 24 tons, I think some arrangement like that shown in Fig. 1. The pitch of the screw and length of handle are necessary as before; the pitch of the spur-wheel, 1¼ inch; its diameter, ·8 of the ladle's diameter; and the screw-wheel or spur-pinion to be made such a size as will produce an effect equal to a screw and wheel, the ratio of the wheel's diameter to the ladle's diameter being found by the following formula:

Fig. 1.

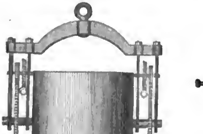


Fig. 2.

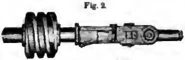


Fig. 3.

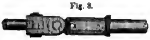


Fig. 4.

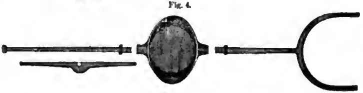


Fig. 5.

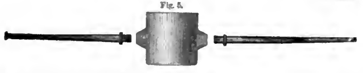
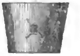


Fig. 6.



$$\frac{1188,\ \text{ladle's contents in lbs.}}{2513\cdot 75} = \text{ratio of screw-wheel's diameter to ladle's diameter.}$$

By way of explanation, I may state that, in all the above-mentioned cases, the screw is supposed to be of wrought-iron, the screw-wheel being cast with concave teeth to suit the screw. All the wheels to have solid plates instead of arms, and all the machinery to be inclosed in sheet-iron casings, to prevent the possibility of melted iron splashing among the teeth. The rod or rods to which the hand-wheels or handles are attached are from 10 to 20 feet long, a universal joint being made on the end to ship into the screw's axle, as in Figs. 2 and 3—thus allowing the ladle to be hoisted or lowered, or any other motion to be made with it, without disturbing the men that are working it, who can, therefore, secure a wide berth, and be free from any annoying heat, and from the chance of becoming confused under such circumstances, when, for perhaps a second or so, all considerations are absorbed by the impulse of self-preservation.

In applying the form and proportions adopted in the construction of crane-ladles to the common double-shank or hand-ladles, I substituted the arrangement shown in Figs. 4, 5, and 6 for the ordinary method of shanking them, with a view to obviate the great inconvenience of the shanks becoming bent, which is occasioned by the hoop carrying the ladle becoming hot. The alteration answered every expectation, not having the slightest trouble with them for years. By driving out the cotter, the shanks can be fixed to another ladle directly, besides many other conveniences which will be directly obvious to the practical man.

If the foregoing, which is based on experiment and calculation, with a wide allowance for contingencies, be considered of any use, and the moulder be thereby enabled to follow his hazardous calling with less risk, I shall consider myself amply repaid for the trouble the subject has cost me. HECTOR SHORT.

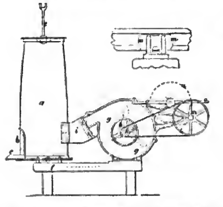
Poplar, London.

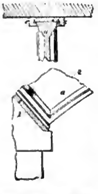
Improvements in Construction of Railroads, Bridges, Locks, &c.

WE find in *Newton's Repertory of Arts* the following process for securing metallic constructions, which has lately been made the subject of a patent in Great Britain. The invention consists in joining iron by pouring melted metal in the joints. The patent includes—first, the method of casting on or near the spot where the work is to be erected, and, second, a portable cupola and appendages, as described below, to be used in such process.

The specification commences with a method of casting railroad chairs by chill or sand moulds; the same being cast in position, the rail itself serving instead of a core. The spike-holes are made by core-pins, which are to be removed as soon as the metal has sufficiently set, to prevent their becoming too tightly fixed by the contraction of the iron in cooling.

The central figure illustrates the application of this part of the invention to fastening a chair (which has been cast in the ordinary manner) to a railway-bar, by casting iron, or other suitable metal, into the space usually occupied by the tightening-key or wedge. In order to effect this, the wooden or other key or fastening is withdrawn, and pieces of wood, or other suitable material, placed at each end of the now vacant place. Sand or ballast is beaten up, whereby, on the pieces being withdrawn, a mould will be formed, into which the molten metal is to be poured, and thus a key will be cast fitting the cavity at every point, and extending over the face of the chair at *m m*, so as to be prevented from leaving its proper situation.





The figures on the right exhibit the application of the improvement to the construction of bridges. The upper is a sectional view of the skew-back, bed-plate, and portion of a girder; the lower, a horizontal section thereof, taken about the line 1 2. The girder *a* is inserted into the mortice *b* of the bed-plate *c*, and then a thin plate of wrought-iron, or other material, is placed so as to cover the mortice *b*, and molten iron, or other suitable metal, is poured into the cavity thus formed, by which means the girder and bed-plate will be firmly united.

A mode of applying the improvement to the construction of locks: The foot-step having been adjusted in its proper position within the box, molten iron, or other suitable metal, is poured into the surrounding space, and thus a perfect union of the two is effected. In a manner similar to this, the ends of girders may be keyed in or fastened together, and various other portions of metallic erections joined or supported. In cases where it is necessary to provide for an expansion and contraction of the parts to which the improvement is applied, the patentee adopts the following or other method of interposing a stratum between the new casting and those parts intended to be joined or supported:—Upon coarse canvas, or other suitable fabric, a coating of loam and lime, or any such substance, is spread, and a piece of such prepared material is placed in contact with the rails, or other parts, so as to cover the entire surface intended to be cast upon.

Thus far the patentee has explained how his improvements may be carried into effect by the use of any ordinary apparatus. He now proceeds to describe a portable cupola for melting the metal to be cast upon the spot where it is desired to be used, and which constitutes the second part of his invention. This apparatus is shown in side elevation on the left. The barrel of the cupola, shown at *a*, is composed of sheet-metal, and lined with fire-bricks or fire-clay; it is provided with a door of the usual construction at *b*, and a spout at *c*; on either side are handles for the convenience of lifting when it is required to be removed from the framework; and to the upper part are attached two standards *e*, upon which the ladles may be placed, in order to keep them in a heated state. The cupola thus formed is attached, by means of bolts, to a framing *f*, upon which is also affixed the casing *g*, of a rotatory-fan *h*. To the fan-casing *g*, two plates i are riveted, and are connected at their forward ends, by means of bolts, to angle-pieces attached to the sides of the cupola; and the casing *g* is also furnished with a conical pipe that projects forward between the plates i, and enters an orifice formed in the barrel of the cupola. Upon the axis of the rotatory-fan *h*, there is a small pulley *k* connected, by means of a band, to a larger pulley *l*, upon the axis whereof there is a pinion *m* taking into the teeth of a wheel *n*, which wheel *n* is capable of being put in motion by means of the winch-handles *o o*, and therefore, by turning such handles, the fan *h* will be caused to rotate and drive a blast of air into the cupola *a*, so as to effect a speedy melting of the metal. This apparatus may readily be conveyed from place to place, where the improved method of applying cast metal, as before described, is required to be used; or it may be applied to the purpose of casting ordinary railway-chairs, or other parts of railways, portions of bridges, locks, or other erections, upon or about the spot where such articles are required to be used.

Tanning in the United States.

(Condensed from a lecture by Col. Zadoc Pratt, before the Mechanics' Institute of this city.)

THE first hemlock leather that was taken to England from the United States, excited the astonishment of a chemist, and he said that it was not *tanned*, but only colored. He declared that he would take out the color and bring it *back to hide.* So he went to work; but after trying to his full satisfaction, he found out that Brother Jonathan had already got ahead of him, and *tanned* what the English chemist could not *untan.*

A cord of hemlock bark weighs about 2200 pounds. When leached or boiled down, it will make three or four hundred pounds of dry hard tan, that can be reduced to the immediate practical use of the art of tanning. Why this number of pounds does not all enter into the hide I am unable to explain; but it is well known that a cord of bark does not make more than sixty or eighty pounds. The cause of the great loss has not been determined. This is a subject which ought to be investigated. Chemists should turn their attention this way, because there is room enough here to add a great deal to the wealth of the world.

There is a great difference in the strength of hemlock bark. That which grows in the region of the Catskill mountains, is the best that I have ever found. The oak bark of Delaware and Maryland is considered the best of that kind. The hemlock of Maine and New Hampshire will not make as much leather, nor as heavy leather, nor will the bark of Michigan or Ohio. Oak bark is the best for tanning upper leather and thin sole-leather, while hemlock is the best, or quite as good, for thick sole-leather.

The Buenos Ayres hides are thought to be the best for sole-leather, yet they will not make as many pounds as the Orinoco hide. City slaughtered hides are tanned principally in oak, and they are used chiefly in the manufacture of harnesses, belt-straps, fine boots and ladies' shoes.

It may be a matter of curiosity and instruction to know how long a tannery will last. This depends much upon whether steam is allowed to come in, and keep the beams and timbers in a moist state. The larger the timber is, the sooner it rots. A tannery of a large and improved class will last from twenty to thirty years, by having the beams renewed two or three times; and this is long enough generally to consume all the bark that from one single neighborhood can be conveniently drawn to the tannery. When tan-vats are sunk in clay, they are never known to wear out. When they are filled in with common earth, or even tan, if the air can be excluded by having them kept wet on both sides, they will last almost any period. The old fashioned heater kind of leaches will last about three years, and the timber around them twice that time.

There are three or four modes of heating that have hitherto been adopted. The late mode, by the pan, I have found to be the cheapest and safest. Formerly wood was used, but now tan, wet from the leaches, is in requisition; it is as good, and cheaper; and will answer to make steam and drive all necessary machinery.

I have before me a statistical account of tanneries in the United States, which has been carefully compiled from the returns of the last census, a brief summary of which I will here give. In the year 1850 there were 6263 tanneries in the United States, of which there were over 1000 in the State of Pennsylvania, while there were only two in the District of Columbia, 1 in New Mexico, 4 in Florida, 8 in Wisconsin, 10 in Rhode Island, 14 in Iowa, 15 in Louisiana, and 16 in Delaware. New York comes nearest to Pennsylvania in numbers, for our state has 942, while Ohio, which has 706, stands next. The capital invested in all the United States tanneries amounts to $19,000,000, of which more than one quarter is in New York. 6,000,000 of hides, and more than two millions and a half of skins, besides 6,000,000 of sheep and other small skins, are tanned a year. Almost one-third of this business is done by the State of New York. The value of the raw material per annum is twenty millions of dollars, of which New York consumes one-third. 21,000 hands are employed in the business of tanning, while several hundred thousand are incidentally employed in cutting timber, drawing bark, and transporting hides to and from the tanneries to the markets. Upwards of six millions of dollars is annually paid to the workmen in the United States tanneries, and over twelve millions of sides of leather are now tanned in the United States every year, whose value amounts to about thirty-three millions of dollars.

I have another table showing the value or price of sole-leather, every year from 1827, when it brought 17½ cents per pound. In 1851, the average price of it throughout the year in the New York market, was 13 cents per pound. During this period of twenty-four years, the highest price it has averaged was in the year 1831, when it brought 19½ cents per pound. It reached the lowest price in 1846, when the average for twelve months was only 11¾ cents.

Table showing the average value or price per pound obtained for Hemlock Sole-Leather during the following years:

	Cents per lb.		Cents per lb.		Cents per lb.
1827	17½	1836	17¼	1845	12½
1828	18¼	1837	16	1846	11¾
1829	18½	1838	17	1847	$14\frac{1}{16}$
1830	18¼	1839	18½	1848	12¾
1831	19½	1840	16¼	1849	15
1832	17¼	1841	16¾	1850	13¼
1833	15¾	1842	$14\frac{1}{16}$	1851	13
1834	13¾	1843	13¾	1852	14½
1835	14¾	1844	13½		

I have another table containing the number of sides of sole-leather inspected in New York city, from 1827 to 1851. In 1827, there were 265,552. This amount gradually increased till 1850, when it rose to 2,200,000.

Sole-Leather inspected in New York city, in the following years:

	No. of Sides.		No. of Sides.
1827	265,532	1840	638,112
1828	284,978	1841	687,101
1829	264,878	1842	886,868
1830	326,298	1843	867,210
1831	440,000	1844	1,048,770
1832	667,000	1845	1,037,500
1833	882,604	1846	1,074,256
1834	828,175	1847	1,168,332
1835	784,165	1848	1,325,146
1836	925,114	1849	1,750,231
1837	890,962	1850	2,100,000
1838	749,556	1851	2,184,543
1839	772,255	1852	2,000,375

For the last four years the value of raw hides and skins, and of manufactured leather, *imported* into the United States, was as follows:

	Raw Hides and Skins Imported.	Manufactures of Leather Imported.
1848	$4,262,069	$208,993
1849	3,507,300	210,143
1850	4,799,031	362,409
1851	5,964,838	411,797

Another table I have made out, shows the number of hides imported into and exported from the port of New York, during each year from 1827 to 1852, and the number of hides consumed or made into leather:

	Hides Imported.	Exported.	Consumed.
1827	259,975	41,545	218,430
1828	268,744	48,369	220,375
1829	308,987	52,023	256,964
1830	475,640	26,305	449,335
1831	772,299	8,017	764,282
1832	975,094	169,493	662,705
1833	892,198	58,282	833,916
1834	700,052	169,856	530,196
1835	868,381	21,903	836,378
1836	942,890	109,273	838,617
1837	623,925	99,356	524,568
1838	543,300	25,695	517,605
1839	561,105	24,186	536,919
1840	520,251	31,825	488,926
1841	633,269	4,245	629,424
1842	635,631	31,286	604,345
1843	653,431	53,633	599,788
1844	854,790	45,615	809,175
1845	777,640	53,633	724,007
1846	636,583	55,824	580,659
1847	990,305	15,236	975,069
1848	972,087	4,025	967,962
1849	1,227,386	none.	—
1850	1,461,304	none.	1,187,510
1851	1,366,239	2,700	1,426,993
1852	1,433,576	none.	1,429,871

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[For Appletons' Mechanics' Magazine.]

Architectural Engineering.

BY J. K. FISHER.

In a well-planned city, house, or store, there are numerous appliances which architects formerly had little to do with, and which, *therefore*, the architectural schoolman leaves to the consideration of the different men who put in the water and drain pipes, the gas-pipes, the warming-pipes or flues, and the ventilators, if any there happen to be. In consequence of this want of unity in the direction, great expense is incurred in the first instance, and perpetual derangements occur, involving frequent expenses for repairs, and damages to the building and its goods and furniture, disgust to its tenants, and great injury to its proprietor. All these evils indicate the necessity of an alliance of architecture with mechanical engineering; and, though it is possible that a mere alliance may serve for utility, it would be far better that the artistic and engineering talents should be united in the same person.

Considerations of great importance demand this union. Beauty of design cannot be preserved unblemished, if the mere engineer, still less if the mere mechanic, be allowed to place his disfigurements wherever it suits his convenience. His gas-pipes deform every corner, his sinks and drain-pipes are put where he finds most room, his water-pipes where they will freeze, his warming-pipes where they will be troublesome, and all his contrivances where they will impair whatever unity and beauty of design the academic architect may have borrowed from his illustrious predecessors. Utility, and durability, and economy of construction, alike require that the engineer should have much to do with the planning of the building. But two heads, in this case, are *not* better than one. The stupidest should be dispensed with, and the clearest should comprehend that it has a nobler function than to be a mere assistant to the boss carpenter. It should comprehend that the beautiful forms its imagination may body forth will be marred, and fulfil no useful function completely, if creative genius neglects its duty, and leaves to the stolid mind of the mere workman the organic details, without which no architectural work can much longer be tolerated.

Mechanical engineering has already become a science. It has its records, its defined principles, its books full of examples and suggestions, and the artist may soon master it, and make it his invaluable servant, instead of his troublesome enemy. Let him look to it, if he would emancipate himself from mortifying contentions with tinkers, plumbers, and other rude ministers to mere necessities, who, without his control and supervision, are like the brute faculties of a lunatic; but who, under his direction, would contribute to place architecture far above the classic models whose beauty makes him forget that art is eternally progressive.

It is but a few years since merchants were content with plain brick-work—mere boss-masonry—without symmetry, style, or attempt at beauty. That time has past, and the boss-masonry is yearly pulled down, or let to the coarsest uses. Some pretension to style is now an element required; and the *draughtsman*, if not the architect, is called upon for service, if not for direction. And when once a few examples of complete architecture, for commercial uses, are placed before the mercantile community, the abortions of the unorganized draughtsmen and craftsmen will fall to the tallow-chandlers and leather-dealers, or be pulled down, to make room for works of utility, sanctified by beauty. That time may come even sooner than dreamy schoolmen expect it, and before they are prepared for it.

I propose, in this paper, to give a few hints which occur to me, as to what is wanted in buildings for ordinary uses. But I make no pretensions to the ability to inform students *exactly* what should be done; all I expect is, to indicate what is wanted, and what, from its general absence, or its defective planning and execution, I suppose to be generally unknown or neglected.

The Hydraulic Apparatus of a city building, especially if it cover the whole lot, is of the utmost importance, and it is usually so constructed as to be frozen, to be clogged, to get dirty, to be a nuisance from its filthiness, and to make frequent or constant noise, and to get out of order. The first consideration of the architectural engineer, in his plan, should be to place his pipes where they will be protected from currents of cold air, by a thick covering of some material that will not conduct heat. The next consideration is, that they should be safe from injury by straining, or other causes; and in order that no accident of this kind may occur, they should be of iron, of such strength that servants cannot injure them by violent punching with iron pokers, and other instruments they may use to drive through them the rubbish they throw in. Nearly all the trash in some buildings is thrown into the bath-tubs and privy-basins; and when it clogs them, it is punched until a hole is punched through the lead pipe, and the building is drenched with foul water. This drenching, after a few repetitions, exasperates the occupants of the lower part of the building, if it be a business building, and they shut off the water at night, which is the only time when it will rise to the upper floors. The water then becomes deficient, the apparatus cannot be flushed, more clogging follows, more punching, more repairs and alterations, each worse than the others, and so on until the best tenants desert the building, in which they are annoyed by intolerable stenches, and cannot at all times obtain water.

As a convenient and economical apparatus for bedrooms and office-closets, I suggest the following:—The basin to be of the height suitable for a wash-stand, so that the wash-bowl may be set upon it, and emptied in it without trouble. The self-acting valve, so much in use, should not be adopted, as they get out of order. The conical cock is more reliable. The wooden seat should be so weighted as always to remain upright, except when held down; and the axis upon which it turns should be provided with arms, from which rods should go to the arms of the cocks and basin-valve. If there be always a head of water, it will be better to have the water-cock provided with a weighted lever, and not connected with the seat-axis; the flushing will then be more effectually done by the rapid flow, and little water will be wasted, as the cock will be closed by the weight, as soon as the hand is withdrawn. The best contrivance for directing the water upon the sides of the basin is a tubular ring around the top, with slits or holes occupying a line clear round, and projecting the water, so that it will strike the sides of the basin at a very acute angle.

The urinary, which has been introduced to prevent the seat from being wet, is superseded by this arrangement of a lifting seat. A great expense, and a greater nuisance, are thus got rid of. The urinaries most in use are not flushed at all; there is a small stream of water running into them, which wet but a small portion of the bottom, and not even spatters the sides, which never get rinsed, and always smell badly. Tobacco quids, stumps of cigars, papers, and miscellaneous matters accumulate, and stop the outlet. There is filling up, fermentation, overflowing, &c., &c. In short, the urinary is a worse than useless addition to the cost of a water-closet.

Ventilation in a water-closet is absolutely necessary. At present it is sufficient to say that from the basin there should be an air passage leading to the main passage through which the impure air is exhausted, and also at the top of the closet there should be another exhaust passage.

To produce a constant and ample general ventilation by the difference of the density of the internal and external columns is an impossibility. It may be much better than no ventilation; but in a large building, where there are many persons, there should be a sure mechanical means of exhaustion. And this may serve also to produce the draught of smoke. An exhausting-fan, such as is sometimes used for steam-boilers, turned by a small steam-engine, or by any power that will work uniformly, will be a great promoter of comfort and health, and will save more than its cost.

The Warming Apparatus of a building full of lodging-rooms or offices is a matter which should be studied by the architectural engineer. Perkins's has been much approved. It is, however, more agreeable to have the warming-pipes at a temperature not much exceeding that of boiling water. Steam is preferable to hot water, when it can be as conveniently used, because the temperature is the same in all parts of the apparatus.

The complaint usually made against these modes of warming is, that they seem to make the air "close" and impure. They do not contribute to ventilation as fires do, and so the air, vitiated by respiration, becomes excessively impure; but if proper means of ventilation be adopted, no unpleasant effects will result from the apparatus.

The fresh air should enter the room just under or behind the warming-pipes, so as to be warmed before it reaches the persons in the room; and the warming surfaces should be so arranged as to radiate as much heat as possible, in order that the air may remain comparatively cool, and the warmth be derived from the radiant heat, as it is from open fires. If these precautions be observed, this mode of warming will be found as agreeable and salubrious as any; far superior to what is called the hot-air mode, in which the air is heated before it enters the room, and it will be nearly as economical as the hot air, and far more economical than separate stoves or grates.

But the effect on safety and the cost of insurance is of great importance. The fire that warms a whole building or a whole block should be in a fire-proof room, under ground. If steam of a temperature not exceeding 250° be used, it cannot set fire to any substances it is likely to meet with; it may therefore be said that it would obviate nearly all the danger which arises from the usual means of warming. To reduce the danger to the least possible amount, the fire-vault should be under the back of the lot, when it is vacant, or under the street.

It may be added that nearly all the cooking may be done by the steam or hot-water apparatus: boiling, and even baking, may be done by it. If hot water be used, a downward loop in the pipe will render it easy to boil in any vessel, by placing it so that the loop will dip into it; and if steam be used, heating vessels containing water saturated with salt will serve as efficient means to boil, in any vessels that may be placed in them.

Gas Lights, being stationary, are safer than movable lights. If ground-glass internal windows be used with judgment, the expense of keeping a feeble light throughout a house, by means of the hall and stair lights, will not be much; and if this be done, movable lights will be little used.

The gas-pipe should always pass through an outer pipe large enough to carry off the smoke and heated air, and any gas that may escape. This external pipe should be inserted into the glass that covers the light, and held firmly by elastic packing; and there should be no occasion to remove the glass, except for the purpose of cleaning. The jets should be projected downward at an angle of about

45°, and the burners so arranged as not to cast shadows where they can be inconvenient. And it may be added that plain ground-glass should be used, so as to conceal the flame from the eye, and no ornaments allowed at the lower part which can cast shadows.

Windows, in narrow streets, should reach to the ceiling, especially if the rooms be deep, otherwise the rooms are lighted only near the windows; and it is more agreeable and useful to have the light come from a source above the usual range of the eye, since it shows objects more distinctly, and does not dazzle the eyes.

Buildings that are deep should not lose the immense advantage of skylights, which will make the upper story more valuable than the one immediately under it, if they be properly designed and constructed. The rolled glass, made in plates six feet square, affords perfect security against leakage. But the boss carpenters who design skylights invariably make them as inelegant and useless as possible. They are mere tunnels, which throw an intense light upon the floor, and leave the walls in darkness. The Italian architects have designed a curved ceiling, which receives light from the skylight, so as to have an even tint, neither too light nor too dark for beauty of effect. The walls also receive an equable light; and it is usual to decorate the ceiling with distemper painting—a cheap and agreeable substitute for which the paper-stainers would furnish, if called upon.

Dumb Waiters, or shafts, with lifting platforms, for the transmission of light articles to the upper rooms, are useful in many cases. If there be a porter, as there should be in every large office building, he will receive packages, and send them up to the tenants, giving them notice by a touch of the bell, or by a call through the speaking tube. Postmen and others would be much relieved by such a help to dispatch, and the wear of stairs and shoe-leather would be economized.

In Naples, it has become usual to have a professional cook in the basement of every large building occupied by families or lodgers. He furnishes meals to those who choose to patronize him, providing all the table furniture. The dumb waiter would very much abridge his journeys, and keep his servants from making too free with small matters.

But it is not necessary, for the purpose of this article, that I should enumerate all the conveniences which an engineer could introduce into a building. It is enough to point out, as clearly as may be, the general benefit of combining with architectural talent and taste so much of the science and genius of the engineer as may be requisite to render buildings convenient, salubrious, and economical. But I cannot well omit the elegant device of Jacob Perkins, by which the power of a steam-engine or other prime motor may be transmitted to all parts of a large building or block, or even to all parts of a town.

He proposed to exhaust the air from a large chamber, from which pipes run to all parts where power is required. Engines, working with atmospheric air, exhaust into these pipes. Thus the heat and odor of oil, that are annoyances attending steam-engines, are entirely avoided; and there is perfect safety from explosions, fires, leakages, &c. Such engines, to do the lifting in a warehouse or store, would be convenient and cheap, if it were the custom to use them; and the ventilating-fans, and small engines for domestic uses, might be worked in this way without being in any way troublesome.

Were such engines in use in stores, they would lead to another improvement. There would be room for carts to enter, and receive their burdens from the hoisting apparatus, without the labor and damage which attend the tumbling of boxes over the sidewalks. All these and other conveniences will, in time, follow the architectural engineer, when he shall have established his just dominion over builders, plumbers, tinkers, and other mere workmen, whose rude tastes are beyond the control of science and reason, and whose mere bone and sinew labor needs to be directed by the brains of men of science and genius, to make it productive of any thing agreeable or economical.

Cunningham's Self-Reefing Topsails.

An opportunity was afforded us, a few days ago, of witnessing the operation of the admirable contrivance for reefing topsails, top-gallant sails, and courses, from the deck, for which Mr. Henry Cunningham, R. N., obtained letters-patent on the 30th November, 1850. So simple are the means which this ingenious mechanical arrangement places at the disposal of the seamen for accomplishing an object which, under the present system, cannot be attempted without encountering some degree of risk, and, even then, without the certainty of succeeding in the contemplated manœuvre. Within the small portion of the currency of the patent which has already elapsed, its advantages have been eagerly sought after and largely resorted to in this country, in the royal and commercial navies of Holland, and in the marines of other continental states. Whether viewed, indeed, as a measure of economy in the working staff of a ship, or as conducive to her security by saving men from exposing themselves, saving time, which frequently becomes in the highest degree precious, and enabling other duties to be more rapidly executed, we cannot conceive that a more useful invention could be added to those which of late years have so greatly improved our shipping.

On the occasion to which we refer, we had the satisfaction of being present on board the brig *Redport*, lying off the eastern end of the north quay of the London Dock. This vessel had had her maintopsail fitted on Mr. Cunningham's plan, and her master and crew spoke in the highest terms of its working on her recent voyage. Several gentlemen connected with shipping also expressed their satisfaction at its wonderful simplicity and efficiency, some idea of which will be conveyed by the circumstance, that the sail was close-reefed by one hand in less than a minute.

Fig. 4.

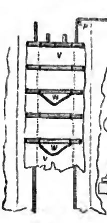


Fig. 1.

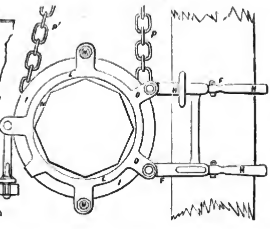
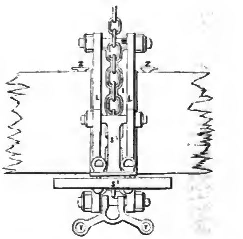


Fig. 2.



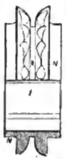
The accompanying figures exhibit the general character of the mechanism, when intended to be applied to vessels of the largest class. For smaller vessels, means even more simple will be sufficient. In all cases, however, the principle upon which the construction proceeds, is the very obvious one of rolling the sail upon the yard, by causing the yard to revolve for that purpose, either by employing its own weight, together with that of the sail and its appendages, to produce the rotation, or by means of pulleys worked from the deck.

Generally, the former method would be the preferable one, and before proceeding further, we propose to give a brief explanation of the necessary arrangements.

Fig. 1 represents a section of the yard and mast. To connect the yard with the mast, a contrivance is employed which, in nautical language, is termed a "parrall." It consists of two hoops H H, which are seen embracing the mast, yet made sufficiently large to slide freely upon it. They are made in two halves, connected by a suitable joint, which unite on the other side, and are there retained by the bolts F. The rings are also connected together, at some small distance apart, by upright bars. This method of construction evidently admits of the parrall being put on or removed from the mast with the greatest ease. To the parrall thus formed is attached the framework which sustains the yard at its middle point, and within which it is susceptible of revolving.

The preparation of the yard, previously to its being mounted, is shown in Figs. 2 and 3. The latter figure represents a metal boss, which is securely fitted upon the middle of the yard and revolves with it, occupying the position which is generally given to the sling-hoop. T, in Fig. 1, represents a bolt which connects two rings, within which the boss and the yard revolve together. These rings are fitted upon collars or bearings on the boss, and they are strongly connected with the hoops of the parrall by the lugs O O, as seen in Fig. 1. The bight of the topsail tye, or haulyards F′, is a piece of chain, which lies in a groove E formed in the centre of a boss I, Fig. 3. In the sides of a groove are a number of "whelps," or teeth, which take into and embrace the several links of the chain.

Fig. 3.



This is the principal part of the construction, and its working will be readily perceived. The fore-end F of the tye is made fast above, and the other end F′ is slackened whenever it is necessary to take in a reef. When that end is let out, the links of the chain take hold of the teeth in the groove of the boss, and cause the yard to revolve. In this way the sail is wound upon the yard, and the surface exposed to the action of the wind diminished. It is evident that the weight of the yard and sail tends to facilitate the operation, and thus the greater thickness and weight of the canvas, instead of rendering more difficult the work of reeling, actually lessen it. If the operation be reversed, a reef will be shaken out; for this purpose it is only necessary to haul upon the slackened end of the tye.

To enable the sail to be wound upon and unloosed from the yard, it is necessary that some provision should be made for the free revolution of the yard in the rings at its middle point. The contrivance to accomplish this purpose is shown in Fig. 4. An upright slot is formed in the sail, reaching from the top downward to a little below the close reef. The edges of the slot are "roped" or finished with the usual rope-binding, and then covered with leather. A set of stretchers or travellers—of which the specification describes three varieties—connect the opposite edges of the slot, but are so perforated as to allow the sail on either side, with its rope edge, to pass freely through. These stretchers are regulated at equal distances apart by means of "grummet-straps" passing through the perforations, and they are covered with canvas on each side, so as to cover the slot as shown in the figure. The lower part only of the canvas is attached to the sail, and the upper traveller is furnished with a screw-bolt, by means of which the canvas strip, with the other travellers, is raised, when a reef is let out. When a reef is being taken in, and the sail is coiled upon the yard, the "ropings" and the sail on either side pass through the perforations in the travellers, and the cam slides down with them.

A "lap-over" is fitted to the top of the sail, to cover the jack-stay and prevent friction. The jewel-blocks at the yard-arms turn upon the points of attachment, so as to resist being turned over by the rotation of the yard.

In many cases, and, indeed with few exceptions, the boss and chain may be superseded by the use of a strong strap coiled upon the yard —a form of the invention which the specification includes.

The advantages of this elegant and highly effective mode of reefing hardly need being pointed out. There is scarcely a nautical man, whatever may be his prejudices in favor of the practice to which he has been accustomed, who would not readily acquiesce in its superior merits, and hail it as a boon, as all have done who have had an opportunity of becoming acquainted with it. Where vessels are "short-handed," or it is necessary to make sail speedily from reduced canvas, or to reduce sail immediately, its useful application is sufficiently evident. With its aid, many a minute may be saved which frequently would seal the doom of a noble ship; and, in any case, employers have the means of introducing into their affairs a judicious economy in the reduction of their crews, which may be set down, at the lowest estimate, at one man for each sail in which it is applied, and of saving, by the diminished duration of the voyage, which henceforth becomes clearly practicable. But above all, on the score of humanity, this valuable invention ought to come into general use, when it is only considered how much the hazardous character of sea-service is increased by the practice of sending men aloft.

We have before us a sheet of testimonials, from a variety of owners and masters, who concur in speaking most highly of this invention, with reference to each of the points on which it recommends itself; but we conceive that the two following incidents will serve as a sufficient illustration of the capabilities of Cunningham's topsail under trying circumstances.

The brig *Speck*, only a few days ago, parted her cables and got upon a lee-shore, and was obliged to carry a press of sail in order to get into Portsmouth. By the use of the patent topsail, which enabled her to make sail and reduce sail as quickly as she desired, she managed to run into Portsmouth in safety. But for this powerful assistance, she must certainly have gone ashore.

For a second instance of the practical efficacy of the invention, we may refer to the *J. C.*, a new brig. The vessel was going into Sunderland during the last heavy gale which visited that part of the coast, and before she came to the broken water, she was under close-reefed topsails. Instantly the men set to work and shook out all her reefs, and the vessel was driven through the broken water in safety. Other vessels in the same circumstances, but not fitted with the patent topsail, broached to, and were taken aback. The opinion of competent sea-officers at Sunderland is, that had these vessels been fitted with Cunningham's topsails, they too would have got through safely.

In conclusion, it is only necessary to observe that this description of topsail can easily be fitted to every vessel rigged according to the present system—all the particulars necessary to be known for fitting it being the tonnage of the vessel, the depth of the close reef, and whether it be a steam or a sailing vessel. The adoption of the patent supersedes the use of reef-tackles, ear-rings, points, cringles, and Flemish horses. As an additional point of economy resulting from the use of this invention, it is proper to mention that the durability of the sail itself is immensely increased; since the absence of the points at once removes the destructive abrasion of the canvas, which is the inevitable consequence of their flapping against it.

This important invention is rapidly increasing in favor in our own and foreign commercial services, and seems destined to give a new impulse to nautical art.—*London Mechanics' Magazine.*

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Sewers and Drains.

On pages 25 to 29, we presented a very labored report of the London Board of Health, giving the results of experiments, &c., highly favorable to the general use of small pipe-drains, and giving tables and other definite prescriptions, with regard to the proper size and inclination under varying circumstances. The late English journals give the following report of the proceedings of the "Institution of Civil Engineers," Dec. 14th, on a paper of somewhat similar import, and in which allusion is directly made to the former article, and in a manner quite condemnatory of its conclusions.

The discussion on Mr. Rawlinson's Paper "On the Drainage of Towns," was again resumed, and occupied the whole of the evening.

It was contended, that the absence of a clear understanding of the subject before the meeting had arisen from certain doctrines having been promulgated, in the published reports of the Board of Health, almost amounting to the prescription of a stereotyped mode of treating, all cases of drainage, however various and peculiar the local circumstances might be. This assumption, by a public board was strongly combated; and it was shown, that to the judgment and experience alone of the engineer, could safely be intrusted the design and execution of works, of such importance to the community, as the sewerage and drainage of cities and towns, in no two of which the circumstances could be identical.

Small pipe-drains might be efficient, if circumstances never changed and accidents never occurred; but the report from the Commissioners of Sewers showed that, notwithstanding every care, the most extraordinary articles found their way into the small conduits, and their entire failure ensued; besides, that unless a heavy pressure of water was used, in conjunction with pipe-drains, stoppages would occur;

and this pressure system, like a great influx of storm-water, for the conveyance of which pipe-drains were not adapted, caused such an accumulation of back-water, as flooded the basements of the houses.

The system of combined back drainage was shown to be decidedly objectionable; and that even as tributary drains the pipes should only be used when they connected directly with main or arterial sewers.

The statement of a greater amount of velocity of flow in, so called, smooth pipes, was proved to be a fallacy and a delusion; the correctness of the formulæ of Du Buat, Eytelwein, Prony, and Poncelet was maintained, and the close approximation of the results of actual experiments, on a large scale, with these formulæ, was exhibited in a tabular form.

It must be admitted, that permanency and durability should be the first consideration of an engineer, in designing drainage work; and it was well known, that at inclinations mentioned by the author of the paper, the abrading action of grit on the bottom of pipes, or even on ordinary bricks, would soon wear them away, therefore thin pipes and hollow bricks were not to be used for main sewers, in great thoroughfares, or where tearing up the streets would be prejudicial to public convenience, or cause danger to the adjoining buildings.

The plan now in course of trial at Leicester, under Mr. Wickstead, for separating the fertilizing matter, in a solid state, from the sewage water, by which the latter was deprived of its noxious properties, was mentioned with praise.

The practice of constructing the main sewers at Liverpool, by cutting the sand-stone rock to a curve, so as to form a natural invert, and arching over the top with bricks, using pipe drains only for separate feeders, from each house, and court, as the case might be, was fully described and stated to be very successful.

The selection of proper outfalls was admitted to be a chief consideration in all designs of sewerage; and pumping was demonstrated to be open to serious objections, on the points of cost, and liability to flooding, in case of extraordinary rain-fall, or of the derangement of the machinery, which must of necessity be in duplicate, as the pipe drains could not be used like large sewers, as elongated reservoirs, during such a stoppage as that of sixteen hours out of every twenty-four hours, which actually occurred, by the action of the tide, on many of the sewers of the south district of London.

Dimensions and Computations of some of the Pittsburg and Cincinnati Packets,

and other large Steam-vessels which navigate the Ohio River, above or below the Falls.

BY WILLIAM J. M'ALPINE, C. E.

PARTS MEASURED, in feet and decimals of a foot.	Pittsburg and Cincinnati Packets.							Louisville and Cincinnati Packets.		Louisville and New Orleans Steamboats.				Steubenville and Wheel'g Packet.	Louisville and Frankft Packet.
	Clipper No. 2.	Brilliant.	Keystone State.	Buckeye State.	Messenger, No. 2.	Cincinnati.	Hibernia, No. 2.	Benjamin Franklin.	Telegraph, No. 2.	Boston.	Alex. Scott.	Peytona.	Magnolia.	Cabinet.	Blue Wing, No. 2.
Lengths—															
Stem to stern,	215·	227·	250·	264·	244·	242·	226·	255·	..	265·	266·	265·	295·	172·	153·
Stem to promenade deck,	28·	28·	28·	28·	29·	28·	28·	..	..	25·	26·	28·	35·	27·	21·
Stem to boilers,	59·	71·	73·	81·	71·	73·	73·	80·	..	75·	82·	83·	88·	55·	40·
Stem to wheelshaft,	145·	157·	162·	172·	160·	157·	152·	155·	..	173·	169·	177·	186·	129.	108·
Of pilot houses,	9·	8·	8·	10·	8·	8·	8·	11·	..	12·	10·	14·	15·	..	10·
Breadths—															
Of beam,	32·	32·	30·	30·	31·	31·	28·	34·	..	34·	34·	33·	35·	27·	27·
Outside of guards,	54·	58·	57·	56·	58·	55·	54·	66·	..	66·	69·	69·	72·	..	37·
Of pilot house,	15·	15·	12·	12·	12·	12·	14·	13·	..	14·	13·	13·	16·	..	10·
Depth of hold,	6·9	7·5	7·2	7·8	7·2	7·4	7·	7·	..	7·5	8·	8·	9·	5·6	5·7
Draught when light,	3·2	3·5	3·3	3·5	2·9	3·3	3·5	..	3·5	4·7	3·8	..	4·4	1·8	2·7
Heights above the surface of the water when light—															
Main deck,	4·4	4·0	4·3	4·5	4·2	4·3	3·5	3·3	4·2	3·5	4·	4·3	5·0	..	3·7
Promenade deck,	15·8	16·	16·	16·	15·	16·	14·5	15·	17·8	15·8	16·3	18·3	21·3	..	10·
Hurricane deck,	22·3	23·6	25·	23·8	22·5	23·	19·5	24·5	27·	26·5	27·	26·5	30·	..	21·
Skylight deck,	25·9	26·1	27·7	25·	25·2	25·5	22·	28·7	31·2	29·	29·5	29·8	34·2	..	23·
Pilot house,	45·1	46·3	46·1	45·7	45·4	45·8	40·5	48·6	50·4	49·5	50·1	43·8	56·7	..	32·5
Wheel house,	26·7	30·7	30·3	30·8	28·4	32·	24·2	29·5	32·3	30·2	34·5	32·	41·5	..	24·
Cross braces,	28·7	..	27·7	34·1	26·8	25·7	43·5	29·5	..	29·5	32·	30·8	38·2	..	25·3
Hog chain braces,	..	51·4	..	52·4	..	..	..	..	..	..	..	..	..	..	..
Paddle Wheels—															
Diameter,	25·	29·5	30·	31·3	30·	32·6	26·	27·5	30·	30·	30·	30·	40·	22·	25·
Diameter of shaft,	1·	1·3	1·3	1·4	1·3	1·3	..	..	..	1.8	..	..	1·5	..	..
Length of bucket,	11·3	11·4	12·	11·5	12·	11·	12·	14·7	12·	14·	15·	15·	12·2	8·3	7·
Width of bucket,	2·	2·2	2·7	2·6	2·5	2·3	2·6	3·	3·	2·5	2·3	2·5	2·4	2·2	2·
Number of sets of arms,	16	20	19	20	18	18	18	18	18	18	20	18	26	15	14
Revolutions per minute,	22	20	19	18	19	18	19	15	18	20	18	15	15	24	23
Chimneys—															
Centre of flues above surf. water,	9·7	9·5	9·5	10·	9·7	9·8	8·1	8·6	9·5	8·6	9·2	9·8	12·	8·2	8·8
Hinges " "	54·5	59·	27·	26·8	64·	21·9	53·7	..	..	..	..	..	..	..	23·6
Top of " "	66·7	71·5	77·5	74·8	74·	84·7	63·7	72·7	79·8	85·8	87·5	73·8	90·4	56·	55·6
Top of, above flues "	57·0	62·	64·0	64·8	64·3	66·9	55·6	64·1	66·3	77·2	76·3	64·0	78·4	47·8	47·3
Distance between chimneys,	..	18·5	18·	..	..	17·8	15·3	..	..	..	..	..	..	..	..
Diameter of	3·66	4·55	4·06	5·50	4·45	4·45	4·5	4·6	4·85	4·75	5·	5·1	5·	..	3.55
Width of iron rings,	2·04	2·07	2·17	2·06	2·04	1·75	2·	2·0	2·0	1·92	2·	1·83	2·0	..	3·56
Boilers—															
Number,	4	5	4	5	5	4	5	6	5	5	6	6	6	2	3
Length,	26·2	26·5	30·8	30·2	30·	28·	27·	32·	30·	34·	31·	32·5	30·	25·	22·
Diameter,	3·08	3·33	3·45	3·5	3·37	3·38	3·42	3·33	3·33	3·5	3·5	3·5	3·5	3·5	3·33
Distance from centre to centre,	3·7	4·	4·1	4·2	4·2	4·1	4·	3·7	4·	4·	4·2	4·2	4·1·	4·	4·
Number of flues,	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Diameter of flues inside,	1·08	1·29	1·45	1·45	1·33	1·27	1·17	1·17	1·33	1·33	1·21	1·25	1·33	1·33	1·25
Draft space, back end,	0·83	0·70	1·	0·75	0·90	1·	0·90	0·92	0·75	0·75	..	..	..	..	..
Draft space, over bridge,	0·42	0·42	0·5	0·64	0·60	0·58	0·50	0·50	0·70	..	..	..	0·83	0·46	..
Pressure of steam, in pounds,	150	140	140	140	150	150	150	180	160	145	140	125	125	185	180

PARTS MEASURED, in feet and decimals of a foot.	Pittsburg and Cincinnati Packets.							Louisville and Cincinnati Packets.		Louisville and New Orleans Steamboats.				Steubenville and Wheel'g Packet.	Louisville and Frankf't Packet.
	Clipper No. 2.	Brilliant.	Keystone State.	Buckeye State.	Messenger, No. 2.	Cincinnati.	Hibernia, No. 2.	Benjamin Franklin.	Telegraph, No. 2.	Bostona.	Alex. Scott.	Peytona.	Magnolia.	Cabinet.	Blue Wing, No. 2.
Heaters—															
Number,	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Diameter,	2·	2·7	2·9	2·9	2·7	2·3	2·5	1·7	2·	2·5	2·3	2·	2·9	1·5	2·2
Length,	4·	8.2	8·2	10·5	10·2	8·3	7·5	6·	6·	6·	8·	8·	8·	5·	6·3
Grate Bars—															
Length,	4·	4·	4·	4·1	4·1	4·	4·	4·	4·	4·	4·1	4·1	4·	4·1	4·
Thickness,	0·07	0·06	0·06	0·08	0·09	0·07	0·07	0.12	0·12	0·17	0·11	0·17	0·06	0·17	0·12
Spaces, width of,	0·07	0·07	0·07	0·08	0·08	0·07	0·16	0·08	0·08	0·06	0·08	0·06	0·06	0·11	0·08
Depth of, below boiler,	1·75	1·54	1·62	1·58	1·50	1·67	1·67	1·83	1·67	1·67	1·83	1·75	2·	1·04	1·67
Engines—															
Number of cylinders,	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Diameter of do.	1·38	2·19	2·12	2·42	2·33	2·	2·38	2·50	2·17	2·21	2·08	2·50	2·50	1·42	1·46
Length of stroke,	7·	8·	8·	8·	7·50	7·	8·	8·	9·	9·	10·	10·	10·	5·50	7·
Cuts off at	5·25	4·	3·5	5·	4·6	3·5	5·	4·	6·75	5·	6·25	6·25	6·25	3·75	4·88
Length of connecting rods,	24·	26·	26·	26·	26·	26·	24·	26·	27·	29·	30·	30·	35·	20·	22·
Size of steam ports, in square ft.	..	..	..	0·2552	..	..	0·1872	..	..	..	..	..	0·3886	..	·1512
Size of escape ports,	..	..	..	0·3984	..	..	0·2988	..	..	..	..	..	0·4814	..	·1800
Diameter of steam valves,	0·33	..	..	0·56	0·50	..	..	0·58	0·62	0·54	..	..	0·71	0·33	..
Diameter of escape valves,	0·46	..	..	0·62	0·58	..	..	0·67	0·71	0 62	..	..	0·79	0·43	..
Diameter of steam pipe,	2·	2·	2·	..	..	..	..	..	..	..	..	..	..	..	..
Diameter of branch pipes,	0·40	0·67	0·56	0·65	0·65	0·50	0·65	0·65	..	0·67	0·67	0·70	0·67	0·34	0·50
Diameter of exhaust pipe,	1·00	0·90	1·10	1·10	1·10	0·80	1·10	1·00	1·00	0·9	1·00	1·20	1·00	1·50	0·80
Engines to work pumps—															
Diameter of cylinder,	0·75	1·00	..	0·75	0·75	0·92	0·67	0·75	0·75	0·67	0·75	0·50	0·92	0·58	0·58
Stroke of do.	2·00	1·50	..	1·83	1·50	1·25	1·83	1·42	1·75	1·42	3·0	1·58	3·25	1·25	..
Number of cold-water pumps,	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Diameter of do. do.	0·46	0·46	0·52	0·54	0·50	0·48	0·42	0·58	0·44	0·46	0·67	0·46	0·58	0·33	0·37
Stroke of do. do.	..	..	..	1·42	1·29	1·50	1·00	1·50	1·75	1·17	2·0	1·58	1·67	0·71	..
Number of hot-water pumps,	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Diameter of do. do.	0·46	0·46	0·52	0·50	0·50	0·48	0·42	0·33	0·42	0·37	0·37	0·33	0·50	0·29	0·29
Stroke of do. do.	..	..	..	1·42	0·29	0·50	1·00	1·50	1·75	1·17	2·0	1·58	1·67	0·71	..
Fuel consumed per trip—															
Coal, bushels,	3200	4000	3000	4000	3000	3000	2500	..	..	..	..	..	..	100·	..
Wood, cords,	None.	50	72	50	60	20	60	..	..	660	..	..	..	..	..
Average speed—															
Passage down, hours,	36	36	36	30	42	33	40	9	10	132	144	..	..	3	..
Passage up, do.	52	52	52	50	52	52	52	15	15	132	144	..	..	3	..
Against four-mile current,	10	10	10	12	9	10	10	10	12	12	11	..	.	7	..
Time boat commenced running,	1848	1846	1850	1850	1848	1850	1847	1848	..	1848	..	..	1850	..	1850
Tonnage, carpenter's measurement,	452·1	525·8	516·4	617·2	526·0	535·3	429·1	594·1	..	481·	710·	686·4	918·4	244·2	216·9
Sectional area, in square feet—															
Of immersion when light,	96 4	107·6	94·1	102·7	82·85	..	92·0	..	..	153·9	122·3	..	150·0	46·6	68·7
Of two chimneys,	20·82	32·24	38·32	47·00	30·82	30·82	31·38	33·16	36·66	34·70	38·64	40·36	..	..	19·58
Of all the flues,	7·36	13·00	13·20	16·70	13·90	10·08	10·80	12·96	13·90	13.90	13·80	14·76	16·68	5·56	7·38
Over bridge wall,	17·06	22·72	20·25	26·95	..	22·73	..	28·12	24·62	..	..	..	..	..	..
Area in square feet, of—															
One bucket of wheel,	22·66	25·69	33·00	30·70	30·00	25·63	32 04	44·25	35·04	35·00	34·95	40.00	29.64	19·16	14·16
Grate surface,	59·2	80·	55·6	86·1	86·1	65·6	80·	88·8	80·	80·	93·32	93·32	98·40	32·80	48·
Spaces in grate,	28·36	41·64	36·25	41·16	39·11	..	53·9	23·92	30·93	20·52	41·41	25·66	47·80	12·02	18·13
Whole heating surface,	1343	1927	1935	2394	2270	1614	1887	2649	2218	25·60	2667	2859	2716	756	947
Contents, cubic feet—															
Between grate bars and boilers,	127	160	137	176	173	139	170	199	170	173	238	230	248	46	99
Boilers for water and steam,	569	775	718	914	889	669	919	1217	858	1125	1320	1363	1191	347	398
Ratio between—															
Buckets and immersion of vessel,	2·13	2·09	1·43	1·67	1·38	..	1·47	..	..	2·20	1·76	..	2·53	1·22	2·43
Grate and effective heating surface,	1 to 14·86	1 to 15·54	1 to 18·90	1 to 17·84	1 to 16·92	1 to 15·91	1 to 15·47	1 to 19·49	1 to 17·82	1 to 20·79	1 to 16·96	1 to 17·99	1 to 17·92	1 to 15·55	1 to 12·77
Contents of boiler and effective heating surface,	1 to 1·53	1 to 1·60	1 to 1·73	1 to 1·68	1 to 1·64	1 to 1·56	1 to 1·35	1 to 1·42	1 to 1·66	1 to 1·48	1 to 1·32	1 to 1·37	1 to 1·48	1 to 1·47	1 to 1·54
Distance traversed by hot air and gases,	107	112	128	122	121	120	107	125	123	142	135	126	185	97	88
Fuel consumed in pounds of coal, and its equivalent in wood—															
Per hour,	2545	2892	3409	4281	3032	..	2989	..	..	3125	..	..	..	1166	..
Per second,	0·71	1·08	0·95	1·19	0.84	..	0·83	..	..	0·87	..	..	..	0·82	..
Per hour on each square foot of grate surface,	43·	48·65	51·97	49·72	35·22	..	37·37	..	..	39·06	..	..	..	35·57	..
Nominal horse-power of all the engines—															
At 100 lbs. steam, per inch,	800	761	659	928	866	514	913	816	895	927	862	1104	1103	267	378
At pressure of steam, stated by engineer of boat,	1200	1093	922	1300	1212	720	1279	1060	1432	1344	1207	1324	1380	360	491

Sloan's Patent Hydrostat for the Prevention of Steam-Boiler Explosions.

(Plate 3.)

THE engraving which forms the frontispiece of the present number of the Magazine, is a faithful representation of the Hydrostat, which many of our readers will recollect was placed on exhibition at the Fair of the American Institute in October last, when a gold medal was awarded to the inventor.

The Hydrostat, as its name indicates, is designed to keep the water in the boiler always at the same level, or within very narrow limits. This is done, not by attempting to supersede the usual feed-pumps, but by interposing a perfect regulating-valve between such and the boiler.

Fig. 1 is a front vertical view of the Hydrostat as arranged to apply to the outside of a boiler. Fig. 2 is a sectional view of the same, in which the shaft a, driven by the engine or other motor, revolves about four times per minute, imparting motion to the cam b, having two curved holes through which pass the slides $c\,c$, attached to the grooved collar d; at the lower ends of the slides $c\,c$ is attached another cam e not fastened to shaft a. To the copper float f is attached a composition metal blade or indicator g, having a flange on either side, serving as a guide in its passage loosely through the slotted rest h fastened on the inside of the case $i\,i\,i\,i$, which forms the steam chamber and water reservoir $k\,k\,k$, with its water and steam connections d' and e'. The dotted line across the float f shows the water-level, with the float resting on the surface, holding the indicator g with the lowest grade or step opposite the edge of the weight m, Figs. 2 and 3. A shaft, forming part of the weight m, passes through a stuffing-box in the outside of the front plate inclosing the steam chamber k; keyed firmly to this shaft is an arm or lever n, with a pin in the other end resting on the cam b, and entering the groove of the collar d; when the shaft a revolves, the cam b coming in contact with the pin, raises it to the highest point of the cam b, thereby, also, lifting the grooved collar d, which carries the slides $c\,c$ and the cam e, also relieving the indicator g from the pressure of the weight m, allowing it to assume the positions which the float determines by resting on the water; the cam b still moving, allows the arm n and grooved collar d to fall gently, until the edge of the weight m again touches one of the steps of the indicator, thus making the position of the cam e dependent upon the elevation or depression of the float. The notched slides o and p are fitted so as to play freely in a chamber cast through the instrument, so that the slides o and p do not come in contact with the steam; these slides are so connected with the supply-valve r, controlling the connection between the two parts of the feed-pipe b' and c', that when p is pushed in by the cam e, the valve is opened, and when o is pushed in, the valve is closed, and the slides are so attached by the piece t, on a wedge-shaped centre, that one slide comes out in proportion as the other is pushed in, and *vice versa*. The water in the plate is represented as high; we will suppose it commences to fall: at each succeeding revolution of the shaft a, the weight m will rest on a higher notch or step of the indicator g, causing the cam e to rise accordingly, which will successively press in the slide p, until the supply-valve r is wide open, when, if the water still continues to fall, the cam e is raised still higher, and, in its revolutions, will press in the slide u, which, by means of the fall v and hub w, causes the hammer a' to strike the bell on the back part of the instrument, thereby giving the first alarm to the engineer that his pumps are not feeding or the water is shut off; and if he cannot remedy the difficulty, and the water continues falling, the cam e is elevated still further, so that it presses in the stem y, which opens the puppet-valve and admits the steam to the whistle z, which sounds a general alarm, notifying the engineer and others that the water in the boilers is getting too low for safety. If the supply begins to be restored again, the float rises, and the parts assume their original position. Fig. 4 is a perspective view of the slide-valve r, with the cover or casing removed.

This instrument is by far the most promising of any for the purpose yet before the public. Being continually in motion, it cannot become useless from neglect, and, in our view, one of its chief merits consists in its mode of operation if out of order. Should the stuffing-box at m be too tightly packed, or if from any cause the easy working of the parts be prevented, the lever n will remain at the top of its stroke, and give the same alarm as if the water was dangerously low. A like result would follow the sinking of the float f. If a leak in the float allows it to fill with water, it carries down the indicator in the same manner as absence of water, and causes the same alarm.

Messrs. Sloan & Leggett, proprietors and manufacturers of the Hydrostat, have requested us to state, for the satisfaction of all interested in putting a stop to steam-boiler explosions, that the delay in supplying orders is wholly attributable to a desire on their part to render the machine, if possible, more perfect than when it was first brought to the notice of the public. They have only been able, however, to improve its *mechanism*, the principles which govern the present beautiful machine being precisely the same as those on which the first rude instrument was constructed. They also desire us to state, that the time thus consumed has enabled them to put the hydrostat to the severest practical test; for, during the past eight or nine months, it has been constantly at work, feeding and controlling their own boilers, at the Empire Iron Works, foot of East 25th street, where it is daily visited by the curious, and subjected to the most scientific and practical investigations.

The general favor with which the first exhibition of this apparatus was received, will be apparent from the following extracts from the daily journals of this city:

[From the New York Commercial Advertiser.]

Among the useful and ingenious inventions exhibited at the Fair of the American Institute, none is more deserving of notice than T. J. Sloan's "patent hydrostat for preventing steam-boiler explosions." This machine is in actual operation on one of the boilers at the Fair. The fatal explosion on the Reindeer has rendered the public mind anxiously alive to the importance of some new precaution against like calamities. There is reason to believe that the desideratum has been supplied by Mr. Sloan's invention. We have attentively examined it, in company with a practical engineer, who is entirely disinterested, and upon whose judgment in this matter the utmost reliance can be placed, and are satisfied that it is no exaggeration to assert, that "the hydrostat is among the most important inventions of the present century." Less could not be said of a machine which appears to provide so successfully for the security of life and property against the perils which have heretofore attended the use of steam power. Indeed, we are quite prepared, after careful observation, to vouch for the statement which we find in the card of the proprietors, namely, that—

"The hydrostat indicates, with unerring certainty, the exact height of the water in the boiler; and keeps the same at the required level, by furnishing a supply commensurate with the evaporation. It also gives instant notice to the eye and ear of any accident to the pumps or feed connections; and, if not heeded, it sounds a general alarm, in time for the fire to be withdrawn from the furnace."

Other advantages claimed for the hydrostat are, that in consequence of the uniform and constant feed which it supplies, the greatest possible amount of heat is extracted from the exhaust steam; that it saves time and fuel; and that it effectually protects the fire-surfaces, tubes, and flues, against the disastrous effects of low water. We are so favorably impressed with the value of the invention that we design to have it applied to the boiler in the press-room of this establishment. In the mean time we commend the model in the Fair to public attention. If it shall prove, after continued trial, that the hydrostat is as effectual a preventive of explosions as it seems to be, it may become a question *whether its general use should not be required by law.*

[From the New York Express.]

The distinguished honor of thus putting an effectual stop to steam-boiler explosions, belongs to Mr. Thomas J. Sloan, of the firm of Sloan & Leggett, proprietors of the Empire Iron Works, foot of East 25th street, in this city. We think it will not be doubted, that the hydrostat is the *ne plus* of all inventions of the kind. If faithful to its promises, all must agree that it is "the only successful effort ever made for the security of life and property against the mighty power of steam."

(From the New York Courier and Enquirer.)

The frequency of explosions of steam-boilers, and the dire consequences which generally follow them, must render any invention proposing to lessen their number, or prevent them entirely, a subject of

Fig 1

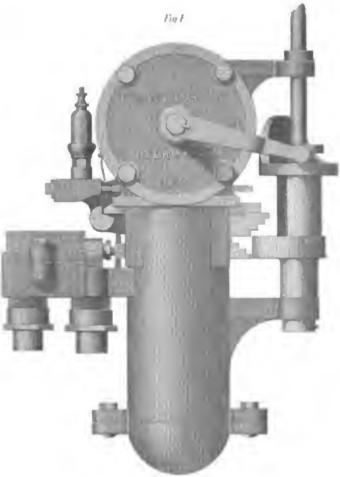


Fig 2

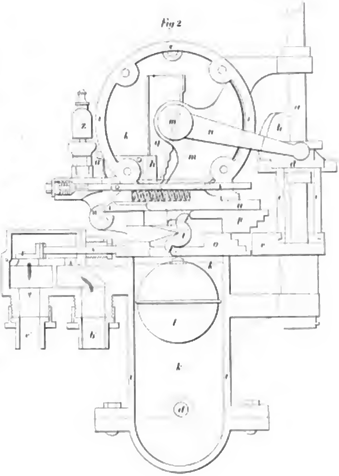


Fig 4

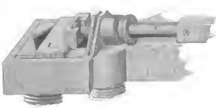
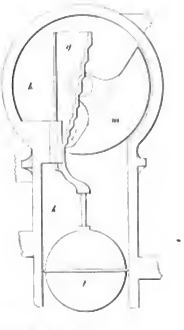


Fig 3



SLOAN & LEGGETT'S HYDROSTAT.

Invented & Patented in the U.S. in [illegible] deep interest not only to engineers and owners of steamboats, but to all, as all are in a greater or less degree interested therein. Among a number of such inventions is T. J. Sloan's patent hydrostat, for preventing steam-boiler explosions. One of these machines is now commanding the highest commendation from the most experienced engineers.

[From the New York Journal of Commerce.]

We have examined T. J. Sloan's patent hydrostat for regulating the height of water in steam-boilers, and have no hesitation in pronouncing it a very valuable invention; economizing time and fuel, and guarding effectually against one of the ordinary causes of explosion. As the details of its construction, though quite simple and readily comprehended on inspection, could not be easily described in popular language, we will notice only those parts which involve its fundamental principle: that of regulating the supply of water and indicating its height by a float within the boiler, without placing the slightest restraint upon the rise or fall of the float.

It is evident that a float will always remain at the surface of the water, provided it is allowed perfect freedom of motion, and it is equally evident that it cannot be made to turn an index or raise a rod outside of the boiler without the friction of a steam-tight aperture, which would lessen its sensibility and render it an unsafe guide.

When Mr. Sloan, therefore, undertakes not only to make it give such an indication to the eye but also to regulate the supply of water, without the attention of the engineer, only calling him to its assistance by shrill whistles when some emergency arises beyond its power to meet, and even to increase the vehemence of its cries as danger becomes imminent; he grapples with difficulties which appear at first sight insurmountable.

We think, however, he has succeeded in overcoming them, and in so simple a manner, that the chief wonder is, that it was never done so completely before.

[From the New York Evening Mirror.]

Among the many remarkable evidences of American genius at the Fair, we have seen nothing to equal, both in importance and ingenuity, an invention called the hydrostat, for preventing steam-boiler explosions. The wholesale murders so repeatedly committed by steam-boilers, all through lack of some unerring gage or regulator, have prepared the public mind to fully appreciate any thorough preventive of explosions, and to hail its invention as a national and world-wide benefit. This hydrostat, we are confident, is such a preventive, and its utility is not greater than its simplicity. Whoever examines it will agree with us, that if it is not at once voluntarily adopted, as we believe it must be, it should be *legislated* into every steam-boiler in the land. With this hydrostat on all our steamers, and in all our steam works, boiler explosions will be at an end.

[From the New York Morning Star.]

The hydrostat should be applied to immediate use, as it will save thousands of lives, to say nothing of wounds and loss of property. This invention is a simple piece of mechanism, and may be seen in full operation at the Fair. It cannot get out of order, except by destroying it entirely, and it whistles very loud when meddled with in the remotest degree. There is, at last, a sufficient guard against being blown up in steamboats—an invention long wanted, and which appeals directly to the interests of the public. If the fearful disasters, we have so often had to record, can be thus easily prevented, and steamboat travelling be rendered perfectly safe by the hydrostat, one is ready to ask, why was not some such thing invented before? Now that it *is* invented, we hope to see it immediately put to use, as every moment that it is neglected, a crime is committed against the people.

[From the New York Tribune.]

The hydrostat, attached to the great steam-engine employed in turning the machinery, is in substance a *self-adjusting boiler-filler*—the pump regularly increasing its feed in proportion to the subsidence of the water in the boiler, which is said to be *exactly* indicated by the float, foam or no foam. In case of any accident to the pump or feed connections, the hydrostat rings a general alarm on its own hook. If this contrivance be indeed what is claimed for it, there should be no more boiler explosions.

[From the Daily National Democrat.]

We cannot, after our elaborate inspection of its manner of working, express too high an opinion of this beautiful and simple piece of mechanism. We left the engine room, perfectly satisfied in our own mind that it cannot be too highly praised, and that wherever it is used—in factories or workshops, or on board steamboats, in any place where steam power is employed—the frightful accidents which so often occur from steam-boiler explosions are utterly impossible. Such was the willing confession of those who examined it while we were present, comprising among others several skilful engineers. The main point in the simplicity and effectiveness of this wonderful invention is, that the float (which has in all former inventions for this purpose been made to perform a certain duty in connection with the machine, and consequently was liable, with the machinery, to go wrong), is, in the hydrostat, altogether independent and unconnected with it. It merely floats on the water, and rises and falls as the water is high or low in the boiler, the exact height being marked on the index by a lever; so that, while the eye is constantly informed of the exact level of the water in the boiler, long before any danger can possibly be incurred, should the attention of the engineer be diverted from the index, the whistle calls his attention to the decrease of the water. We really can see no possibility of the general alarm being brought into action; but should that be the case by any strange inadvertency, there is still ample time to prevent the catastrophe that, where this exquisite and useful invention is not employed, would almost inevitably occur. Even if we had the skill to give a professional description of the hydrostat, it would be impossible in the limited space alloted us to convey a correct idea of its manifold advantages over every other invention for the prevention of steam-boiler explosions; but we earnestly recommend all persons interested in mechanics, and especially engineers, to direct their attention on visiting the Fair, to T. J. Sloan's patent hydrostat. We believe that, if it were in general use, and we have no doubt it will soon be, steam-boiler explosions would become unknown.

In closing this article, we must not omit to add that one great advantage possessed by the hydrostat is, that it cannot be tampered with by designing or ignorant persons; for, as soon as it is improperly meddled with, it sends forth an unearthly sound, that warns every one within half a mile, that it is being falsely dealt with. Even in case of accident to the float, which can only occur through a hole being worn in it, intimation is instantly given to those in attendance that such is the case.

Take it all in all, it is one of the most perfect pieces of mechanism we have ever seen, and the recent sad accidents by steam-boiler explosions, render it at this moment especially an object of interest.

[For Appletons' Mechanics' Magazine.]

Church Clocks.

IN one thing, we Americans, with all our boasted mechanical ingenuity and skill, are far, very far, behind some other nations. Church clocks have been sadly neglected in this country. In going from one place to another, not more than fifteen or twenty miles distant, it is not unfrequent to find as great a difference in the principal clocks as 30 minutes, when the difference of local time is 0.

In England, the church clocks in the principal towns are made to run with the accuracy of an astronomical clock or regulator; but here, no one who is desirous of obtaining the true time takes it from the clock on the steeple of the next church, but he goes into a watchmaker's shop; or if, perchance, he be fortunate enough to have a chronometer, to an observatory.

Fig. 1.

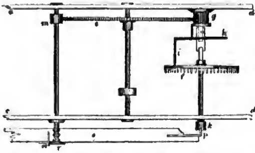
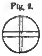


Fig. 2.



One of the principal causes of the irregularity of turret clocks is the action of the wind on the hands. Another cause of error is the varying power acting on the escapement, through a train of wheels exposed (as many are) to great changes of temperature; and worse, to dust and wet, and ignorant sextons. Another and slighter cause, comparatively, is the shortness of the pendulum, and its want of compensation. I have no doubt that many clockmakers will ridicule the idea of compensating the pendulum of a church clock; and well they may, as things now go.

The first-named objection it is proposed to remove, by the introduction of a new spring remontoir escapement. The diagram Fig. 1 illustrates this remontoir. It is the invention of Mr. E. B. Denison of London, and has already been applied to many of the clocks manufactured by Dent and others.

Fig. 1 is a plan of the works of this escapement. $a\,d$ and $c\,d'$ are the side-plates, as usual; the wheel marked e is the centre-wheel (there being only three wheels in the train); f is the scape-wheel. The end of its arbor is supported in a bush made fast to a stud which is screwed to the plate $a\,b$. This stud also carries the scape-wheel pinion g, which revolves freely around it. This pinion has an arm projecting from it, one end of which is secured to a spiral spring, marked h. The outer extremity of this spring is attached to the arm i, and thus the pinion g drives the scape-wheel, by the intervention of the spring. On the end of the scape-wheel arbor, marked k, is a small steel cylinder, shown on a larger scale in Fig. 2. This cylinder has two notches across the end; one of these notches is wide and shallow—the other is narrow and deep. m is a pinion, of half the number of leaves that g has. On the end of its arbor, which is prolonged outside of the frame, is a ratchet r, with twelve or fourteen teeth; a catch n, taking into these teeth, keeps the fly o in place. On each end of this fly is a spring arm, one of which is shown at p. The ends of these arms are fitted so that one will go through the wide notch in the cylinder k; the other arm is fitted to go only through the narrow notch.

The operation of the escapement is as follows:—Assuming the scape-wheel to turn in two minutes, every thirty seconds, a notch of the cylinder will come opposite the arm of the fly, thus permitting the fly to move around; but it can only move half a revolution, because the other arm will not pass through the same notch as the first one did. Now in this half revolution of the fly, the pinion g was turned one-fourth around, and therefore wound up the spring h a quarter of a turn. The force of the spring now drives the scape-wheel until another thirty seconds has passed, when the arm p is permitted to slip through its own notch, when the spring is again wound up.

The hands, it will be evident, will move only every half minute, instead of every half second, as they now do.

It will be seen that the scape-wheel is detached from the train, so that a heavy weight may be put on to drive the hands freely in all weather. By means of the ratchet r, the force of the remontoir spring may be increased or diminished. It will be also seen that the detachment of the scape-wheel prevents any irregularities of the maintaining force from reaching the escapement. A. O. B.

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Increase of Screw-propulsion in the British Navy.

A CONTRACT was entered into last week at the Admiralty, by two eminent engineering firms, for the construction of eight pairs of engines, each pair to be of the collective power of 400 horses, and all adapted for screw-propelled ships of war. John Penn & Son have obtained the contract for the 400-horse power engines for the Royal Albert, 120, building at Woolwich dockyard, and now decided to have new engines on John Penn & Son's patent trunk principle, which gave such satisfaction in the Agamemnon, 90, also built at this dockyard. The engines, although nominally of 400-horse power, will be made to work up the power of 1200 horses; but engines of 600 nominal horse power would have been desirable in the Royal Albert, as she is a powerful first-class ship of war, and worthy of having engines of equal power, at least, as the Agamemnon—the latter vessel being fitted with engines of that power. The other ships to be converted into screw steam-ships, and fitted each with engines of 400-horse power, by John Penn & Son, are the Princess Royal, 90, building at Portsmouth; the Royal George, 120, at Sheerness; and the Euryalus, 50, building at Chatham. Messrs. Maudslay, Sons, and Field have contracted for the other four pairs of engines of 400-horse power each, and they are to be fitted with screw-propellers, for the following ships of war:—The Exmouth, 90, building at Devonport; the Clarence, 84, building at Devonport: the Cressy, 80, building at Chatham; and the Majestic, 80, also building at Chatham. The engines of 600-horse power, making by John Penn & Son, for the St. Jean d'Acre, 100, are now nearly completed, and will be ready for commencing fitting on board when she is launched from Devonport dockyard, where she is building, and nearly ready for launching. The engines of the Royal Albert will be ready in June next, by which time the vessel will be ready for launching; and in the course of another year, it may be calculated that the following powerful ships will be ready for sea, and all fitted with screw propellers:

The Royal Albert	120, building at Woolwich.
The Duke of Wellington	140, fitting at Portsmouth.
The Royal George	120, to be con'd at Sheerness.
The St. Jean d'Acre	100, building at Devonport.
The Princess Royal	90, building at Portsmouth.
The Agamemnon	90, fitting at Sheerness.
The Exmouth	90, building at Devonport.
The Clarence	84, building at Devonport.
The Sanspareil	81, fitting at Devonport.
The Majestic	80, building at Chatham.
The Cressy	80, building at Chatham.
The Imperieuse	50, fitting at Woolwich.
The Euryalus	50, building at Chatham.
Making a total of	1175 guns of large calibre.

The above vessels are all in so advanced a state, that there will be no difficulty in completing them next year, should any emergency arise to require their services; and, with the vessels already fitted with screw propellers, they will form one of the most powerful channel fleets ever possessed by this country. The above list does not include any of the guard-ships, or any of the ships now building which are ordered to be fitted with engines already in store; the Algiers, 90, building at Devonport; the Hannibal, 90, building at Deptford, and several others, being ordered to be fitted with engines already made for screw ships of war.—*English paper.*

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LIST OF PATENTS.

Issued from the U. S. Patent Office during the month of January, 1853.

J. P. Arnold, of Louisville, Ky., for improvement in Machine for Heckling Flax and Hemp.

Claim.—I do not confine myself to any particular form or arrangement of the parts, so long as the machine is so constructed that it will operate as set forth.

I claim the method of heckling hemp, by subjecting it to the action of a series of mixed beaters and combs, the teeth of the latter being of varying length—some of them projecting so far, and others beyond the beaters, and the whole operating substantially as set forth.

Also a rest, having a narrow slot open at one end, in combination with a concave projecting beyond the end of the cylinder at the open end of the rest, as set forth.

James T. Bruen and James G. Wilson, of Hastings, N. Y., for improvement in Machine for Sawing Stone.

Claim.—Lifting the saws at or sufficiently near the middle of the stroke, to effect the specified purpose.

Also interposing india-rubber, or its equivalent, between the ways, and the inclined projection which lift the saw-frame, as specified.

J. J. Clark, of Philadelphia, Pa., for improvement in Self-Winding Telegraphic Registers.

Claim.—I do not claim the application of the click and ratchet-wheel, operated by an electro-magnet, vibrating a lever to cause rotation and obtain power; but I claim regulating the current, through the coil of the electro-magnet of the self-winding apparatus, by means of the relative motion of the spring shaft and spring-box, so that when the spring has been wound up to a certain point, that current shall be cut off, and the self-winding apparatus cease to act.

J. D. Dale, of Philadelphia, Pa., for improvement in Planing Mouldings.

Claim.—Arranging a series of sets of moulding-cutters or plane irons, side by side, along the length of a rotating stock, as specified, when this is combined with rotating saws, or their equivalents, interposed and projecting beyond the periphery of the cutter for separating the several mouldings formed on one plank, as specified, whereby the operations of planing the several mouldings, and separating them, are performed at one and the same operation, and accuracy of work secured, as set forth.

J. D. Dale, of Philadelphia, Pa., for improvement in Planing Mouldings.

Claim.—I do not limit myself to the number of knives or rollers to be used, nor to the manner of operating the rollers, as these may be varied at pleasure, nor to the use of all my improvements in one machine.

I claim attaching the planing-iron to a plane stock, which is hinged to an adjustable sliding-plate, as specified, by means of which combination the plane iron can be readily thrown up to be sharpened, without the necessity of taking it out of the machine, as set forth.

Also the adjustable sliding plane, as described, when combined with the separate movable mouth-piece by the means as described, so that in setting the plane iron, a different motion is given to the mouth-piece, in order to vary, to any desired thickness, the shaving, that when the plane is set to cut a thick or thin shaving, the mouth-piece shall receive a corresponding set, as described.

George & George W. Fenga, of Frederick, Md., for improvement in Grain Washers.

Claim.—The method, as described, of separating grain from smut, garlic, and other impurities, by first washing it through a reservoir of water, where the separation takes place, and then conveying the washed grain to a drying apparatus, where it is thoroughly dried, the whole operation being performed as set forth.

J. S. Gallaher, Jr., of Washington, D. C., for improvement in Crutches.

Claim.—First, the revolving, plain, or corrugated spring top, in combination with an air cushion, as described.

Second, in combination with the revolving spring top, the sliding joint applied to the staff of a crutch, in the manner described.

Third, in combination with the sliding staff, the revolving handle, extension ferrule, and elastic bulb, as set forth.

J. C. Bidwell & J. Hall, of Pittsburg, Pa., executors of Samuel Hall, deceased, for improvement in Hill-side Plows.

Claim.—Manner of arranging the mould-boards upon the land side, to wit, placing their hinges at such a distance from each other on each side of the centre of the land side, that each mould-board may be supported by the edges and projection, as far as practicable, from the hinges, and rest upon the grooves near the middle of the land side, as set forth.

Richard Hollings, of Boston, Mass., for improvement in hose-pipes.

Claim.—Hanging the spread to the hose-pipe, by means of pins passing through the collar (which allow it to vibrate), in combination with adjusting apparatus, for varying the position of the spread in the manner specified.

B. F. Jenkins & Luke L. Knight, of Barre, Mass., for improvement in Lathes for Irregular Forms.

Claim.—We do not claim the vibrating cutter-cylinder and vibrating work-carriage; but we claim giving the necessary relative vibrations to the cutter-cylinder and work-carriage, by crank-pins or eccentrics upon the axis of a pair of toothed wheels, of which one is toothed all round its periphery, and the other upon any suitable portion of its periphery, the latter wheel having a constant rotary motion applied, which gives an intermittent rotary motion to the former wheel, whereby the said cutter-cylinder and work-carriage receive the one constant vibratory motion, and the other an intermittent vibratory motion, as described.

Merritt, Packham, & Lucius O. Palmer, of Utica, N. Y., for improvement in Ore Washers.

Claim.—The interior cylinder, with indented ends and wings, attached as described, to operate as a discharging apparatus attached to the interior of an inclined revolving screen, as specified.

F. C. Schaffer, of Brooklyn, N. Y., for improvement in Potate Diggers.

Claim.—I am aware that machines have been previously used for digging potatoes, but in these machines the potatoes are dug or scooped from the hills by means of a concave or scoop formed of a single piece, the brush cylinder carrying the potatoes up the concave and into the receptacle. I, therefore, do not claim the above arrangement; but I claim the arrangement and combination of the scoop and endless apron, by which the potatoes are dug or scooped from the hills, and the dirt thoroughly separated therefrom, as they pass up the endless apron into the receptacle.

William Watson, of Chicago, Ill., for improvement in Tongueing and Grooving Machines.

Claim.—The method, substantially as described, of tongueing and grooving boards, by means of knives arranged in the plane of the sides of the tongues or grooves, with their cutting edges inclined towards their rear extremities, so as to cut gradually deeper and deeper as the board passes them, when in combination with cutting instruments arranged between these side knives to reduce or remove the surplus wood which is severed by them, as specified.

Jeptha A. Wilkinson, of Fireplace, N. Y., for improvement in Printing Presses.

Claim.—I am not aware that type have ever been formed with two parallel sides and two sides tapering on the radii of a circle, with a groove on one side and a projection on the other, so that on setting the parallel sides together, and the tapering sides together, and placing the projecting beads into the corresponding grooves, a cylinder is formed of firmly secured type, with their faces equidistant from the centre, by which means the printing is effected, the same as though the whole were solid in a perfect cylindrical form. This constitutes the essence of my invention, and the other parts claimed are the means to use, to form, regulate, and work the main invention, and for parts growing out of or connected with the same.

First, the application of notches or grooves and beads, or projections on the shafts of type, tapered to the radii of a circle, for the purpose of locking said type together, and securing it in place on a cylinder, as described.

Second, the mode described, of forming column lines, rules, rings, and blocking, so that they are adapted to the cylinder and to the type, with notches and projections, to lock into the type and cylinder, as described.

Third, the mode described of constructing the type-cylinder, with heads, the one head having a bead or projection, the other with a notch or groove around in its face, near the edge, for the purpose of receiving and securing the type or other parts composed on the surface of said cylinders, such heads being fitted with means to compress and hold the type and parts in a cylindrical form, for the purpose of printing by a rotary movement, as described.

Fourth, the mode of constructing the compositor's stick in the form of the part of a cylinder, with flanches, having beads or grooves, so as to hold the type in segments of a circle while composing or setting up, preparatory to the placing of the same in the galley or proof-cylinder, as described.

Fifth, the mode of constructing and applying the galley or proof-cylinder, so that it shall receive and hold the type in circular form from the composing stick, and retain the type and the needful parts in place for correction and proof, and for transferring the same to the type-cylinder, the parts being constructed and operating as described.

Sixth, the mode of forming and constructing the type-holder or grab, to inclose, take hold of, and securely lift a mass of type from the galley or proof-cylinder, and transfer the mass either to the type-cylinder or to the stack, for future use, or to reverse or vary either of these operations as may be needed, the instrument being constructed and operating in the manner described.

Seventh, the application and arrangement of the pulleys, bands, and guide-plates, so placed and moving, so as to carry the sheet of paper from the press, in lines diverging vertically, and conveying horizontally, under, between, and over the guide-plates, thereby presenting the paper in a folded form to the compressing-rollers, as described.

Eighth, the application of the press-rollers to compress the folded paper, and lead that out of the folding apparatus, and the combination of the standing roller, revolving shear, standing shear, valve, and cam, to effect the cutting of the folded paper as it issues from the rollers, and guide the fresh cut edge clear of the standing shear, the whole being as described.

Rudolph Kreter, of New York city (assignor to Robert Nunns & John Clark), for improvement in Pianoforte Hammers.

Claim.—First, the application of the felt or other covering material to the whole set of hammer-heads at one operation, as described.

Second, the clamp, bar, levers, pulleys, and block, with the sliding frame, in combination, as described, but without limiting myself to the precise shapes and proportions or positions of the said parts, provided the arrangement embraces the means of holding the set of hammer-heads, and of bringing them to bear upon a table containing the strips of felt described, and also holding and moving the whole together, either horizontally or vertically, to and from the jaws of the vise, as set forth.

Third, the vise, in combination with, and inclosing the bar and block, as described.

Fourth, the lip-pieces, in combination with said vise, as described.

Fifth, the levers and springs, in combination with the vise, for producing the pressure upon the sides of the felt, during the passage of the hammer-heads between the jaws of the vise, as described.

Sixth, the method of increasing or diminishing the pressure of the levers upon the vise, by means of the movable bridge, in combination with the press, as described.

Walter Hunt, assignor to Charles T. Kipp, of New York, N. Y., for improvement in Bottle Stoppers.

Claim.—I am aware that there have been other plans of self-acting stoppers recently introduced, all of which have the same objection of producing an uncertain scattering or over-discharge, and are constructed upon principles widely different from my plan.

I claim the combination of the circular cap and central shaft, viz., the swivel, pendulous and sliding motions, by means of which, without regard to which side of the stopper is upward (when it is placed horizontally, or nearly so), the under portion of the cap swings off from the flange, thereby producing a downward opening between the two for the requisite discharge of the liquids contained.

T. Baylis & Daniel Williams, of Tecumseh, Michigan, for improvement in Rakes to Harvesters.

Claim.—Construction and method of operating the rake, together with the use of the jointed brake, in facilitating the discharge of the sheaf at the rear of the machine, as set forth.

Nathan Chapin, of New York city, for improvement in Lathes for Interior and Exterior Surfaces.

Claim.—Constructing the clamping-heads with a V projection on the interior face, in combination with the orifices to act through said clamps and V projection, for the purpose of introducing slats, in order to retain the piece firmly in position during the operation of turning the interior and exterior surfaces.

Second, I claim giving to the sliding and vibrating interior cutter, suspended on the stationary mandrel motion, corresponding to the pattern to be turned, by a rod passing through the stationary mandrel, as described.

Moses G. Farmer, of Salem, Mass., for improvement in Galvanic Batteries.

Claim.—Improved cell, made as described, viz., with a part only of it porous, so as to permit the electricity to pass from the nitric acid or liquid within it through such part, and into the liquid surrounding the cell, the remainder of the cell being made, by glazing or other means, impervious to the passage of electricity, and acid or liquid through it, as specified.

P. Frost, of Springfield, Vt., for improvement in Scythe Fastenings.

Claim.—Peculiar construction of the loop and the set ring, with the grooves, in the manner set forth.

Ammi M. George, of Nashua, N. H., for improvement in Circular Saws.

Claim.—In combination with a circular saw, driven by friction, near its periphery, the guard-plate, with its arbor, around which the saw runs, and by which it is held into the wood, and on which the board or veneer, being sawed, may rest and relieve the saw from all friction therefrom, and by which means I am enabled to cut boards or veneers, of nearly equal width with the diameter of the saw, as described.

J. L. Gilliland, of Brooklyn, N. Y., for improvement in Fire Polishing Glass.

Claim.—Method, substantially as described, of fire-polishing glass, by means of a rotating table, provided with a hollow handle, or its equivalent and geer, by which said table can be rotated, as described.

Peter P. R. Hayden, of New York city, for improvement in Buckles.

Claim.—Constructing the buckle in the manner described, viz., by uniting or connecting the two ends of the body of the buckle, by means of a boss formed at each of the two ends of the body, said bosses being in contact with each other, and forming a bulb, around which one end of the tongue is clasped; the end of the tongue, which surrounds the bulb, having a recess or groove in its inner surface, which conforms to the convexity of the bulb, and keeps or binds the bosses firmly together, and also keeps the tongue in its proper place.

Silas A. Hedges, of Lancaster, Ohio, for improvement in Manure Spreaders.

Claim.—Constructing a manure cart with two bodies, the front one of which is raised or tilted, for the discharge of manure into the rear one, by the action of a hind axle, by means of another axle and tackle, when thrown into gear by the hand lever, arranged as set forth.

I also particularly claim the combination of the endless apron, the tilting-body, and raising the tail-board simultaneously with throwing in geer the endless slotted apron, as set forth.

William Mann, of Philadelphia, Pa., for improvement in Copying Paper. Antedated July 11, 1852.

Claim.—The copying paper described, composed of Manilla fibre, or the equivalent thereof, tempered with cotton or its equivalent, as set forth.

Andrew Mayer, of Philadelphia, Pa., for improvement in Screw-Cutting Dies.

Claim.—Arranging solid dies between the side-plates, or their equivalents of a stock, in such manner that they are free to play, to a limited distance, in a plane perpendicular to the axis of the bolt or pipe to be screwed, while they are, at the same time, incapable of revolution in the same place, as described.

Richard Montgomery, of New York city, for improvement in Steam-Boilers.

Claim.—Rivating together the overlapping flanges of the opposite side of the sheet-flues in steam-boilers, in the manner described, whereby the flues are firmly attached each to each, and the usual flue-sheet is dispensed with; and also certain advantages in construction attained in other parts of the boiler, as described.

Also the method of connecting a series of flues and water-spaces with the roof or arch of the fire-box, by means of tongues which project from the latter, and are secured alternately to the faces of the water-spaces and to the tops of the flues.

Daniel Pease, Jr., of Floyd, N. Y., for Improvement in Smut Machines.

Claim.—Employment of the adjustable deflector, set at an angle, to throw the grain in different directions, in combination with the receiver; the top of the said receiver being adjustable to any height desired, and the front piece of the same being set in such a position, in relation to the deflector, that it will, when the grain strikes the deflector, be thrown against the said plane surface, which, from its peculiar position, will throw the grain in a partially spread state up against the adjustable top, which causes it to spread still more, and then to fall down on the ribbed bottom, and pass off through the wind pipe.

Also, causing the grain to spread to a greater or less degree, by making the top of the receiver adjustable to different heights, as described.

Robert W. Andrews, of Stafford, Conn., for improvement in Treadles of Looms.

Claim.—Operating each treadle by means of a mover, having two outwardly-acting cam surfaces of unequal lengths combined in one piece, producing the movements and retentions substantially as set forth.

I also claim such a form and arrangement, respectively, of the treadles as can be reversed in their positions upon their fulcrums, and thereby cause a reversal of the movements and retentions of the said treadles, as set forth.

Charles L. Bander, of Cleveland, Ohio, for improvement in Bedstead Fastenings.

Claim.—Fastenings of bedsteads by the use of a metal bar, having upon its extremities arms with inner faces, formed of sections of screws, which arms work against the faces of castings secured in the bed-posts, and to the ends of the rails, thus drawing the ends of the rails against the posts; the faces of these castings, against which the arms of the bar work, being likewise constructed of sections of screws, the joint being kept close and the bedstead firm by the pressure of the slat frame, caused by the weight of the bed and its occupants upon arms attached to the metal bar, thus forming a self-tightening fastening—the whole being constructed and arranged as set forth.

D. H. Chamberlin (assignor to C. G. Howard), of Boston, Mass., for improvement in Machinery for Reducing Metal Bars.

Claim.—Combination of the bolster with the three rollers, as arranged, and made to operate together substantially as specified; the object of the said bolster being to prevent the over-riding or squeezing out of the metal, so as to form a fin between the rollers.

Jos. Contner, of Milroy, Pa., for improvement in Saddle Trees.

Claim.—Connecting the bridge spring-seat to the pommel of the saddle, by hooking or fastening the hook or curvature on the front end of the longitudinal centre-spring of the bridge spring-seat to the semi-oval or semi-circular steel or iron-plate or strap, fastened down, underneath the pommel, by screws, or otherwise, through its legs, to the legs of the pommel, to give additional spring or play, by its motion on its pivots, to the seat, and to allow the bridge spring-seat to be disconnected from the frame of the saddle when necessary, and to strengthen the pommel, by rendering the hole through it, near the horn (which weakens it), for connecting with the seat, unnecessary.

George and David Cook, of New Haven, Conn., for improvement in Driving Circular Saws, &c.

Claim.—Curved or hooked tooth-pinion acting in the manner set forth.

Edward Everett, of Lawrence, Mass., and S. T. Thomas, of Lowell, Mass., for improvement in Harness Boards for Jacquard Looms.

Claim.—Sectional harness-board, in combination with the movable supporting bars placed on each side of the frame, for the purpose of adjusting and retaining said harness-boards in the position required; the whole constructed, combined, and arranged as specified.

James S. Hogeland, of Lafayette, Ind., for improvement in Wool Condensers.

Claim.—Method described of detaching the ropings from the rub-roller, and guiding them on their passage to the spool, in such manner as to prevent them from being unequally deflected, and thereby unequally stretched, by means of a relief and guide-roller, arranged and operating as set forth.

John Griffiths, of Philadelphia, Pa., for improvement in Screw-cutting Dies.

Claim.—Circular die, with an offset, which makes a cutting edge, which is held in position by a bolt and screw, and the threads which are cut in its periphery being parallel, instead of having a running pitch, as described.

J. L. Kingsley, of New York city, for improvement in Compounds for Stereotype Plates.

Claim.—I do not claim the mixture of the gums, gutta percha, india-rubber, &c., with other non-elastic gums, resins, &c., or shellac, sulphur, &c., nor do I claim vulcanizing, nor do I use vulcanized compounds, nor do I claim mixing the elastic gums with the alkaline earths or earth proper, nor with the carbonates, nor the sulphates of these bases, as pulverized marble, plaster of Paris, Epsom salts, &c., all of these things having been done before by Nelson Goodyear and others, for hardening and otherwise modifying the elastic gums; but I claim the making of stereotype moulds and plates of the raw or uncured gum, combined with the pulverized oxide of iron and antimony, or their equivalents, as set forth.

J. P. Smith, of Hummelstown, Pa., for improvement in Corn Shellers.

Claim.—Bevelled spring blocks or shelling-bars, in separate pieces, in the manner and for the purpose set forth; but I do not claim to be the inventor of spring-blocks or shelling-bars.

J. W. Webb (assignor to Benjamin Gould), of Aurora, N. Y., for improvement in Valves of Rotary Steam-Engines.

Claim.—Making two exhaust openings, such as described, separate and distinct from each other, through each steam and cut-off valve; said valves having seats on the upper as well as lower side of the steam-chamber; each of said exhaust openings communicating with the exhaust-chamber, through apertures in the upper side of the steam-chamber, which are opened and closed at pleasure, by slides, used in connection with the valves, for governing or reversing the engine.

Samuel & William H. Witherow (assignor to Samuel Witherow), of Gettysburgh, Pa., for improvement in Seed Planters.

Claim.—Arranging the spring and roller within a tube, forming one end of the hopper, in such manner as to prevent any more seed from leaving the hopper than is required for planting—the whole arranged as set forth.

Also, the arrangement of the drag-bar under the plough-beam, and passing through the adjustable hanger, and a slot in the neck of the mould-board, for the purpose of giving additional lateral support to it, and protecting it from the earth, which runs up on the mould-board, in turning the furrows, the whole being arranged and combined as described.

John Bell, of Harlem, N. Y., for improvement in method of Joining Corners of Boxes, &c.

Claim.—Joining corners of boxes, &c., by means of double oblique parallel mortises and tenons, so that neither the sides nor ends can be separated or displaced, without previous removal of the top and bottom of the box, as set forth.

James Black & Orson Beecher, of Philadelphia, Pa., for improvements in Working the Condenser attached to Steam Diaphragm Pumps.

Claim.—First, the pipe E, valves L L, or their equivalents, so constructed and arranged as to draw the air, &c., from the condenser, and drive it into the discharge-pipe or elsewhere, by the column of water in said pipe, operated by the working of the diaphragm, which causes said column of water to work the equivalent of an air-pump to the condenser.

Second, the pipe D and the valve S, or their equivalents, so constructed and arranged as to draw the water from the condenser by the raising of the diaphragm, thus causing the water-pump to work an exhaust-pump, or its equivalent, to the condenser, at the same time that it does its ordinary work, as described.

Charles Bourgard, of New York, N. Y., for improvement in Manufacturing Wigs.

Claim.—I do not confine myself to the precise means of giving motion to or adjusting the several parts essential to the operation of the machine; I know that it is possible to move and adjust them in other ways, to produce the same effect; and I do not claim the employment of the hooked or bearded needle, irrespective of the manner of its employment.

But I claim (for the purpose of making the partings, or those parts of wigs, and all articles of a similar nature, where the artificial scalp or skin is visible, and the surrounding parts), the employment of two or more adjustable slide frames, for carrying the silk or other material, into which the hair is to be inserted, in combination, as described, with a reciprocating hooked or barbed needle, either the said frame or needle having such a movement as is necessary to insert the hairs at a proper distance apart.

Henry Bretney, of Springfield, Ohio, for improvement in Tanning Hides and Skins.

Claim.—Continuously towing the hides, in separated layers, through the tanning liquor, in such manner that each hide, made fast only at one edge or end to the towing mechanism, will be gently stretched and kept spread out by the resistance of the liquor, which is caused freely to circulate in contact with both sides or surfaces of the hides, whereby every hide of a quantity, however large, is equally and constantly exposed to the action of the tanning liquor, and the stretching action upon the hides, adjusted as specified.

Freeman Palmer, of Conneaut, Ohio, for Improved Feed Motion in Sewing Machines.

Claim.—Arrangement and combination of parts, by which the material to be sewed is carried around under the needle, in a way to secure any required length of stitch, consisting of the shaft and the screw regulator, together with the lever and clamp upon the feed-wheel, substantially as described.

Samuel M. Perkins, of Springfield, Pa., for improvement in Seamless Felt Wearing Apparel.

Claim.—The art or method, as described, of making seamless felt articles of use and wearing apparel, by giving the batting of wool or fur the desired shape, and uniting its edges, where required, with silk, or any other non-shrinking equivalent, or by such shrinking threads or fibre as will resume their original state when dry, substantially as set forth.

I do not claim the mode of carding or preparing the batting, as that was well known long before my invention; nor do I claim the shrinking or felting process, as that has also been well known.

William H. Lazelle, of New York, N. Y. (assignor to Henry F. Wilson, of New York, N. Y.), and S. E. Fenwick, of Washington, D. C., for improvement in Machines for Paring Apples.

Claim.—Apple-paring machine, constructed with a stationary circular rack or way, in combination with a traversing lever, for operating the fork on which the apple or other article is placed, the said handle having a pinion on it, which traverses the said rack, and gives rotary motion to the fork, making the apple to revolve against the swinging spring-knife, while the handle is pushed backwards and forwards in a horizontal direction by the operator, in the manner described.

Joseph Pillant, of New Orleans, La., for improvement in the Frames of Pianofortes.

Claim.—In combination with the metallic frame of a pianoforte, the movable part which supports the bridge, and which is raised or lowered at pleasure, by means of a key operating through the screws and levers, or their equivalents, for the purpose of raising or lowering the tone of the instrument, and at the same time preserving its accord, substantially as described.

Jos. W. Archibald, of Porto Rico, West Indies (assignor to Horace Southmayd, of New York, N. Y.), for improvement in Sugar-draining Machines.

Claim.—Employment of a fibrous or flexible bag, made of cotton, linen, hair, cloth, or any other substance placed loosely or secured by loops, as described, in a centrifugal or depurating sugar machine, inside the wire-gauze cylinder, and containing the sugar, said bag not being permanently attached to the machine by any screw or clamp, &c., but to be freely placed in and lifted out of the machine entirely, when the sugar is depurated, as set forth.

Abiathar F. Potter, of Boston, Mass., for improved Gold Washer and Amalgamator.

Claim.—First, a wheel, or its equivalent, arranged in the tube above mentioned, so as to be operated by the water containing the metals, &c., as it issues or descends in the tube, so as to agitate the water by the motion of the wheel, whether it is made to operate some other agitating apparatus, or otherwise.

Second, the openings, or their equivalents, in combination with the openings, or their equivalents, substantially as described, for giving such direction to the water as will move the mercury in the manner set forth.

Thomas Prosser, of New York, N. Y., for improvement in Expanding Drills.

Claim.—Combination of the inclined cutter, with a screw cut thereon, bevel screw-pinion, or its equivalent and collar arranged in the manner described, so that by holding said collar, during the rotation of the drill, a continuous feed motion is communicated to the cutter.

Pater Taltavull, of Washington, D. C., for improvement in Omnibus Registers.

Claim.—The spring, operated and arranged in combination with the inclined planes and escapement-tube, in the manner and for the purpose described.

Augustus B. Childs, of Rochester, N. Y., for improvement in Winnowers of Grain.

Claim.—Regulating the blast for the second winnowing of grain, by combining with the revolving-fan, which generates both the first and second blast, and a compensating safety-valve, as set forth; but I make no claim to a spring-valve in itself, as such a contrivance is well known for various purposes.

I also claim the self-regulating valve, which prevents the admission of air into the machine, while it opens, to discharge the impurities separated from the grain, and thus prevents an undue accumulation of them at the bottom of the air-chamber.

Charles B. Hutchinson, of Waterloo, N. Y., for improvement in Machinery for Cutting Barrel Heads.

Claim.—In relation to the head-turning apparatus, I am aware that there is nothing novel in the use of the clamp-rings, as such, or of rotating cutting tools, such as fleam-knives, chamfering-chisels, and face-planes, set on disks, or otherwise; but the peculiar combination and arrangement of all these which I have adopted I believe to be wholly novel, and not heretofore used, either for the purpose specified, or any other.

I claim the use of clamp-rings to hold the pieces of heading, and hung in bearings on opposite sides, or in any equivalent way, so as to be reversible in combination with the adjustable rotating cutters, to cut and bevel the edge of the head, and with the face-cutters arranged upon the disk, as described, whereby the opposite sides of the head may be successively presented to the action of the cutting tools, and the head cut out, chamfered, and face dressed or cut out and chamfered only, at one operation.

Elijah F. Parker, of Proctorsville, Vt., for improvements in Frames for Lanterns.

Claim.—I am aware that offsets have been turned on the frames of lanterns, for holding the glass, &c., but the corner pieces are made up of two or more pieces soldered together; this I do not claim. But I claim the turning of grooved or sunken flanges upon the frames of lanterns, so that when the top and bottom are united, the flanges for holding the glass, mica, or their equivalents, shall be already in place to receive them, without any further soldering, as described.

George B. Read, of New York, N. Y., for improved Screw Wrench.

Claim.—I do not claim having the jaw attached to a shank, and the shank passing through a recess in the jaw c, independent of the mode of operating the jaws; but I claim the arrangement of the several parts, as described, viz., the jaw c, being attached by a pivot to the stock, and having a recess through it, through which the shank of the adjustable jaw E passes, the shank being provided with a rack, into which a pawl attached to the end of the stock catches, said pawl being kept into the rack by the spring, by which arrangement the two jaws E and C are forced against the sides of the nut as the handle of the wrench is turned, and the jaws made to bear or bind harder upon or near the corners of the nut—thus preventing the jaws from slipping around it.

William and Matthias Stratton, of Philadelphia, Pa., for improvement in Portable Gas Apparatus.

Claim.—We claim the construction of the stove, removable gates in the ends, for the introduction of the retort and the movable section under the resin holder, in the manner as set forth.

Benjamin Shiverick, of North Sandwich, Mass., for improvement in the mode of Feeding Resin in the Fires of Glass Furnaces.

Claim.—I claim combining the long conical valve and the discharge-tube, by means of a set screw and nut, and supporting spring, whereby the flow of the melted resin may not only be regulated, but when any interruption takes place, the attendant can readily remove the same, either by lifting the valve or pressing on it, and such valve be subsequently moved back to its former position by the spring.

Richard Solis, of New Brunswick, N. J., for improvement in Manufacture of India-Rubber.

Claim.—The manufacture of india-rubber fabrics by the mixture of ground or powdered vulcanized rubber with the ordinary india-rubber of commerce.

Isaac L. Pulvermacher, of Breslau, Prussia, for improvements in Voltaic Batteries.

Claim.—I do not claim simply making galvanic elements of negative and positive metals with porous, non-conducting substance interposed.

What I claim is constructing galvanic elements of positive and negative metals separated from each other by a porous, non-conducting substance, when the said porous, non-conducting substance is surrounded and held by one or both the said metals, substantially as specified.

Also forming the galvanic elements, by coiling, in the form of helices, the positive and negative wires in grooves, previously made in the surface of an inner core of wood or other porous substance, as specified, so that when the wires are wrapped around in the said grooves, they shall both be in contact with the porous substance within, and separated from each other, as specified.

Also forming a chain of a series of elements, as described, by means of ties or links, for the purpose specified.

Finally, the method of interrupting the current of electricity by means of the spring vibrating conductor, interposed as described, for the purpose of breaking and closing the circuit by the movement of the human body, or other like motion, as set forth.

RE-ISSUE.

Nehemiah Hodge, of North Adams, Mass., for improvements in Discharging Water from Vessels.

Claim.—The combination of a system of two series of chambers, connecting-pipes, discharging-pipes, receiving hole or orifice, and ventilating pipes, as arranged, connected, applied to the hold of a navigable vessel, and made to operate during the rolling or pitching movements thereof, for the purpose of elevating and discharging water therefrom, as set forth.

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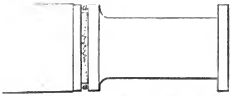
Correspondence.

The Fractured Axle.

In your last number of the Engineer's Journal, I perceive a statement in regard to the accident at Andover, and its cause. Perhaps a sketch of the form of that part of the axle in which the fracture occurred may prove interesting. It is given below:



The groove *a a* was turned near the journal of the axle, to receive a thickness of leather, for the purpose of excluding dust from the bearing. The fracture had started in this groove, and followed the course of the dotted line. The broken angle is in the office of the Superintendent of the Boston and Maine Railroad, together with a part of another axle broken in the same manner. Without this *sharp-cornered groove*, the axles might have been now running.—Very truly yours, ZERAH COLBURN.

Lowell, Feb. 11, 1853.

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An Obscure Point.

To the Editor of the Mechanics' Magazine.

THERE is one point in Capt. Ericsson's otherwise clear explanation of his stationary caloric engine, which is a little obscure to the writer of this communication, and which seems essential to a clear understanding of its power.

It appears that the valve g remains open until the working-piston e has reached three-fourths of the full-up stroke. Is not the pressure in the air-receiver a and the working-cylinder d the same during that time? (the regenerator f forming no obstruction to prevent the pressure becoming equal.) If this is so, is it not necessary that the pressure in the supply-cylinder b shall equal or exceed that in the air-receiver a (and therefore in the working-cylinder d also), before the valve c' will be opened? If this is admitted, it appears to the writer that at, and just previous to, the closing of the valve g, the air under the working-piston would have no moving power upon it, and the engine would have nothing but its momentum to keep it in motion until the valve g was closed, and the fire beneath had time to expand the air still in the working-cylinder.

A further explanation would no doubt clear this point of its obscurity, and enable many of your unprofessional readers to arrive at what they have been long desiring—a clear understanding of the working power of the *caloric engine.* C. G. S.

Philadelphia, Feb. 5, 1853.

The writer of the above labors under what may be a common error, in seeming to suppose that air or other matter is *first* heated, and *afterwards* expands, when, in fact, the operations are strictly synchronous. It is as true to say that the expansion from heat takes place before the heat is received, and in order to its reception, as to say that it is after it, and in consequence of it. The expansion or the increase of pressure due to increased heat is *at the same time* with the rise in temperature; consequently the principal expansion of the air filling the working-cylinder d (Plate 2) takes place in passing the wires of the regenerator, for there its principal increase of heat is obtained. In consequence of this, a greater volume of air must pass through the last disk at z than passed through the first at x, in consequence of its expansion in passing through the intermediate disks. The expansion which takes place after entering the working-cylinder *d* is only that due to the few degrees (say 30°) received from the fire through the cylinder bottom.

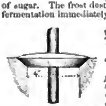
So much for the *locale* of the expansion. The main difficulty of the writer is still more easily removed. If we understand aright, he is at a loss to conceive how the engine can have power to move while the pressure in one direction against the supply-piston is equal to the pressure in the other direction against the working-cylinder. In other words, if the pressure in *d* is, at best, only equal to that in the receiver *a*, and the pressure in *b* also fully equal to that in *a*, how can the force of *d* overcome that of *b*, and cause motion? It is due entirely to the difference in area of the working and supply-pistons. In consequence of its smaller diameter, the area of the supply-cylinder is but about one-half that of the working-cylinder; consequently an equal pressure per square inch on each would give a tendency to motion equal to the pressure on the difference of area. The elaborate calculations on page 39 with regard to the engines of the ship, still further illustrate this subject.

Apprentices' Department.

Answers and Explanations of Questions on page 44.

1st. The strain on the rope *a* is 500 lbs.; the same as with one horse. Practically, the strain is *less* when two horses or men pull against each other, than when one alone pulls against a fixed object, because it is less affected by sudden jerks. E. F., New York. Also correctly answered by a number. A majority, however, have incorrectly pronounced it 1000 lbs.

2d. The sweetness of potatoes after being frozen is due to the formation of sugar. The frost destroys their vegetative principle, and the saccharine fermentation immediately commencing, grape sugar begins to be formed.



3d. The first part of this problem is simply to find the area of a circle which is 4 inches in diameter. The area of any circle may be found by the following

RULE.—*Multiply the square of the diameter by the constant number* ·785398.

The square of a number means *the number multiplied by itself*. The decimal number ·785398 may be always used to find the area of a circle, when the diameter is known, and is therefore called a "constant number," or a "constant."

The diameter of the valve is 4 inches; which, squared, makes $4^2=4\times4=16$. Sixteen multiplied by the constant given above makes $16\times\cdot785398=12\cdot566368$ or about 12½. 12½ square inches, then, is the area of the valve.

To decide at what pressure the steam will begin to blow off, we have simply to divide the whole weight on the valve, 1000 lbs., by the number of square inches therein. This will give exactly the pressure of steam per square inch required to equal the weight on the valve. The least pressure of steam exceeding this amount will cause it to rise. Therefore, $1000\div12\frac{1}{2}=80$. A pressure of 80 lbs., then, is the pressure at which the steam will begin to blow off.

Our more advanced readers will excuse this very elementary style of treating the above. We desire to awaken every mechanic—particularly every young mechanic—to the importance of a knowledge of mathematics, and, if possible, to interest him in the same. We intend giving in each number one or more questions, which, with the explanations and rules accompanying, may be mastered by any one familiar with the simple rules and the use of decimals. It is only necessary to know that + between two quantities means *add*, — means *subtract*, × means *multiply*, and ÷ means *divide*, in order to comprehend the first questions in each series. These alone will gradually lead to the development of some very important rules; but, by all means, if an old or new book on arithmetic or geometry can be procured, study it carefully and patiently. The fourth question is but little more difficult.

4th. The screw to be cut requiring 18 threads per inch, and the main screw having two, the product of the driving-wheels must be to that of the driven as 2 to 18. Now these being put in the form of a fraction, $\frac{2}{18}$, we have only to break these two numbers into 4 equivalents, thus: $\frac{2\times1}{3\times6}$, or $\frac{2\times1}{6\times3}$=ratios of the wheels required; which may be multiplied at pleasure, to suit the sizes of the wheels most convenient to geer; care being taken to keep the fraction the same value. If we multiply each number by 12, we have $\frac{24\times12}{36\times72}$, or $\frac{24\times18}{72\times54}$, or $\frac{24\times36}{72\times108}$, which show the number of teeth required.

Questions.

Question 5. In consequence of a difference of level, there is a lock in a river to enable vessels to pass in the usual manner. Is there any difference in the expenditure of water between a vessel passing *down* and passing *up*, the draught of water being the same in both experiments? Again, is there any difference in the expenditure of water between a laden vessel and a light one passing up or down?

Question 6. The weight of cold fresh water is 62½ lbs. per cubic foot. Required, the weight of water filling a circular cistern 20 feet in diameter, and 14 feet deep. Also, the number of gallons in the same—one gallon being 231 cubic inches.

Question 7. Suppose a steamship to be propelled steadily 12, and an air ship 7 miles per hour. Suppose, also, a sailing ship, of the same sharp model, to make on her course, according to weather, during $\frac{1}{8}$ of the time, 13 miles per hour, $\frac{13}{24}$ of the time 9 miles per hour, ¼ of the time 6 miles per hour, and the remaining $\frac{1}{12}$ nothing. Required, the comparative speed of each of the latter, compared with the former, and with each other.

Question 8. In a pic-nic grove is a common rope swing. The centre of oscillation is 75 feet from the points of suspension or axis of motion, and may be assumed to swing through an arc of 100 feet. Required, the number of vibrations per minute, the point and amount of its greatest velocity, and the strain on the ropes when the persons swinging weigh 300 lbs.

New Publications.

"THE Marine Steam-engine." By Thomas J. Main and Thomas Brown. Second edition. Hebert, London, 1852.

"A Treatise on the Economy of Fuel." By Alfred P. Ryder. M. Taylor, London, 1852.

"Industrial Drawing." By D. H. Mahon, LL. D. John Wiley, New York, 1852.

The above were more fully noticed in page 44.

"A Treatise on Hydraulics, for the Use of Engineers." By J. F. D'Aubuisson De Voisins. Translated and adapted to the English units of measure by Joseph Bennett, C. E. The treatise by D'Aubuisson, in the form here presented, is perhaps the most valuable which *could be*, certainly the most desirable which *has been*, offered the profession, for many years. The laborious reductions appear to have been admirably performed; and the mechanical execution of the work, with the exception of the plates, appears faultless. The work should be in the library of every millwright and civil engineer. The principal subjects are treated in the following order:—Flowage through orifices, over weirs, in channels; formulæ of motion and applications; "remous," back flowage, eddies, &c.; action upon constructions; pipes; jets; impulse; motors of various kinds; apparatus for raising water. We shall present a few liberal extracts from this work on some future occasion. Little, Brown, & Co., Boston, 1852.

"Treatise on American Engineering." Illustrated by large and detailed engravings. By F. Mono, Esq., C. E. (Issued in numbers.) H. S. Samuels & Co., New York, 1853. See advertisement of this splendid work on second page of cover.

Monthly Notes.

GENERAL STATISTICS.—We gather from the January number of *The American Railway Guide*:—On the 1st of January, 1853, there were in the United States 13,227 miles of complete railroad, 12,927 miles of railroad in various stages of progress, and about 7000 miles in the hands of the engineers, which will be built within the next three or four years—making a total of 33,155 miles of railroad, which will soon traverse the country, and which, at an average cost of $30,000 (a well-ascertained average) for each mile of road, including equipments, &c., will have consumed a capital amounting to $994,650,000, as follows:

13,227 miles completed - - - -	$396,810,000
12,928 miles in progress - - - -	387,840,000
7,000 miles under survey - - -	210,000,000
33,155 Total - - - - - -	$994,650,000

or in round numbers—$1,000,000,000—one billion of dollars: a sum which, at 6 per cent., would yield $60,000,000 annually, or more than sufficient to cover all the expenses of the United States Government, and of the government of every State composing the United States!—if administered with republican economy. This estimate of the railroads of the United States differs materially from that published by the census office, and that by Mr. Andrews in his late report to Government—but is based upon actual ascertainments. Both these documents, however, refer to a date anterior to 1853.

M. Decoster, at Paris, has lately invented a novel method of lubricating bearings, especially applicable to light shafting, and which is thus described in the London Artisan:—The bearing is made rather wider than usual, and a small disk is fitted on the shaft, which dips in a reservoir of oil in the base of the hanging carriage or plummer-block, and by its revolution, raises the oil and distributes it over the bearing. A tight fitting cap covers in the whole bearing, and prevents the access of dust. Bearings of this description, we are assured, will run for more than a twelvemonth with one supply of oil. M. Decoster is replacing all his line shafting with shafting of a much smaller diameter, but running at a higher speed. This arrangement saves great expense in constructing mills, and is attended with no inconvenience, if the system of lubricating just described is adopted.

POWER AT NIAGARA.—The immense water-power at Niagara has long been a tempting inducement to enterprise, but fully devoted to the realm of use rather than fancy, as the *Mechanics' Magazine* must necessarily be, we cannot but regret any step tending to reduce the proud cataract to the condition of the now humbled Passaic at Patterson. The Passaic Fall, long famous for its beauty, has been completely drained and utilized by a canal, much to the regret of its admirers. Niagara is stronger, and will bear some tapping, but it may be hoped that the works of art will not be so forced upon the view as to destroy its wild and solemn grandeur. An eastern company has been lately organized, as we are informed, to make available a portion of the power of this great natural wonder, and the route of the canal has been partly located. It is to commence, according to the *Lockport Courier*, about half-a-mile above the Falls, and pass directly through the present village.

GREAT SHIP CANAL ACROSS THE ISTHMUS OF DARIEN.—A company has been advertised in London, for the construction of a ship canal connecting the Atlantic and Pacific at the isthmus of Darien. About seven miles of the proposed route has not been surveyed; but, from general observation, the whole cost of the work is estimated at £15,000 sterling.

THE TEHUANTEPEC ROUTE.—A contract has been lately concluded with the Mexican government, and the work at the isthmus of Tehuantepec will, no doubt, be vigorously carried forward. The Pacific Railroad projects are supposed to be dead—at least for the present. Will some engineer connected with the Tehuantepec surveys send us a brief sketch of the progress of the work, a profile of the route, &c.?

RELATION BETWEEN THE SPOTS IN THE SUN AND THE MAGNETIC NEEDLE.—According to observations made by M. Rodolphus Wolf, Director of the Observatory at Berne, it appears that the number of spots on the sun have their maximum and minimum at the same time as the variations of the needle. It follows from this, that the cause of these two changes on the sun and on the earth, must be the same, and, consequently, from this discovery, it will be possible to solve several important problems, whose solution has hitherto never been attempted.

STEAMSHIP UNCLE SAM.—This new ship, now running between New York and Aspinwall, was designed and built by E. Mills, Esq.; the engine by the Allaire Works. Her dimensions are as follows:—Length of deck, 230 feet; breadth of beam, 36 feet; depth of hold, 21½ feet. She has a single beam engine—diameter of cylinder, 65 inches; stroke, 11 feet. The wheels are 31 feet diameter; 28 arms and 28 buckets, 8 feet 4 inches long, and 18 inches wide. Two return flue boilers, 27 feet long; diameter of shell, 11 feet 2 inches; front, 12 feet 6 inches; three furnaces in each boiler, 7 feet 3 inches long. At her trial trip, she made 18 revolutions; pressure of steam, 27 lbs.; vacuum, 27½ inches; cutting off at half stroke.

The Caloric Cylinders.

A SENTIMENT seems very generally to pervade the community, that the new motor, if adopted, will remove every possible cause of danger from fracture or explosion, either to the passenger or attendant. This could not have been claimed by the inventor—at least not to the extent stated; but while it is immaterial where the idea originated, it may be well to examine how far it is or is not the case. The entire absence of boilers, which, in the use of steam, are the principal sources of danger from explosion, would seem at once to indicate the safety of the caloric apparatus. There is, however, danger from rupture of the huge cylinders; and it is not impossible that in actual practice, exposed to concussions, overheatings, and other sources of injury, the air-engine may be proved to be less safe than the condensing steam-engine.

The boilers are the *principal* sources of danger in the use of steam, but not the only ones, as accidents little less serious sometimes result from the bursting of pipes or cylinders. The principal reasons why the bursting of cylinders are less frequent and less dangerous, are their small size, and the great surplus of strength which is generally given them. The ability of any cylinder of a given thickness to resist a pressure from within is inversely as the diameter. This rule applies to steam-boilers, steam or air cylinders, water-pipes, and every variety of cylindrical vessel. Doubling the size renders it liable to burst with half the pressure. The largest sizes of steam-cylinders are but from 7 to 9 feet in diameter. The cylinders of the Ericsson are 14 feet; and cylinders of 16, 20, and even larger sizes, are proposed, to increase the power of the caloric engines. With these sizes to construct, and with ordinary regard to expense, we may expect cylinders of a thickness only sufficient to offer what each designer may consider a reasonable surplus of strength. In fact, were no motives of economy to be considered, the immense weight of these working and supply cylinders, with the intermediate framework, piled upon each other, like four towers, on the keelsons of a ship, imperatively requires that a minimum of metal should be carefully studied. Cast-iron is a material of much less absolute strength, and far less uniformity, than wrought, which brings us to the unpleasant conclusion, that instead of boilers of sound and tough wrought-iron, the caloric ship is provided with four brittle cylinders of cast-iron, of equal, or perhaps greater size.

The pressure yet approached in the caloric engine of the Ericsson is but slight, in comparison with the usual American steam-pressure, even in condensing-engines. The contemplated pressure of 12 lbs. per square inch, should it be reached and maintained in the cylinders of the Ericsson, would be something less than in the majority of marine boilers;* but the consequences of a rupture, owing to the very high temperature of the element employed, are quite incalculable.

A large volume of compressed air, if by accident set free in the engine-room and hold of a ship, so far from being perfectly harmless, may be, at a temperature of 400° to 500°, one of the most terrific enemies which the ingenuity of man has yet been called on to encounter. The scalding effect of steam, at only from 212 to 250 degrees, was fearfully exhibited in the case of the Reindeer explosion on the Hudson River, last summer. The steam in this case destroyed over 30 lives, not by the explosive effect in mangling the persons, but principally by scalding the lungs of those who inhaled it. The small or large amount of heat remaining in the air, when finally expelled from the engine through the regenerator, need not disguise the fact of its actual working temperature in the cylinder, which is stated to be about 450° Fahrenheit. This is above the temperature at which block-tin melts, and nearly up to the point at which bright iron or steel becomes straw-colored. To place in a strong light the degree to which the air is heated in the cylinders of the caloric engine, it may be safely said to be as much hotter than boiling water as the latter is hotter than ice. The effect of a volume of such air would probably be fatal to all who inhaled it, even if considerably diluted by mixture with the surrounding air; and other evils may suggest themselves, such as inflaming light combustibles, &c., throughout a ship. The only safety, then, consists in the strength and ability of the cylinders, which, as we have already seen, cannot be absolute perfection, and diminishes with every increase of size and power. Possibly there are considerations which have not yet occurred to us, tending to negative these conclusions; but in the present view of the case, although we would not be understood as pronouncing the caloric engine an especially dangerous invention, we should unhesitatingly pronounce it inferior, so far as safety alone is concerned, to the well managed condensing steam-engine.

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* The average pressure in the boilers of the U. S. war steamer Susquehanna, on her trial trip, was 10 lbs.; the Mississippi, 12; Saranac, 14; San Jacinto, 15; Michigan, 15; Georgia, 15; Washington, 14; J. L. Stevens, 14; United States, 12; Northerner, 18; Falcon, 14; Philadelphia, 15; Republic, 12; Ohio, 15; Hermann, 12; Cherokee, 16; Atlantic, 14; Pacific, 14; Baltic, 14; Arctic, 14, &c. The pressure in the majority of English marine boilers is somewhat less.

Engines of the Ericsson.

WE enjoyed an opportunity, on Friday, the 11th ult., of examining, for the first time, the engines of the Ericsson, and are now able to present some points of importance, which have been heretofore either unnoticed or suppressed by her visitors.

We are more unfavorably inclined towards these engines than before. So much space having been already devoted to this interesting experiment in the present and previous numbers, this notice will be principally confined to the new facts developed. The regenerator—the heart and lungs of the whole system—seems greatly diminished in importance. The stationary engine presented in our last number, and from the working of which the minute observations of temperature, effect of regenerator, &c., have so far been calculated, had in its regenerator 200 disks of woven wire, 10 picks to the inch, or 100 meshes to each square inch. The "Ericsson's" regenerator has only a thickness of some 10 or 12 inches, containing 50 disks of wire, the meshes of which are 4 to the inch, linear measurement, or 16 meshes per square inch. The wire being only about No. 18, the effect of this regenerator, either in injuriously retarding the passage of the air, or in economizing the heat, must be much less than before supposed; and the performance of the engines of the Ericsson must proportionably approach that of an air-engine working without a regenerator—a condition which, as abundantly proved in the calculations on page 39, is much less economical and desirable than any ordinary steam-engine.

The workmanship of the engine, and the arrangement of the starting geer, is worthy of the highest admiration. Omitting all the minor details, by far the most important point on which we would remark is the capacity and adaptation of the furnaces to consume, at pleasure, nearly or quite as much coal as our steamships. There are two fires under each cylinder, the grates of each being, as near as could be measured by the eye, with the fires burning, three feet three inches by five feet. These dimensions would give the Ericsson 130 square feet of grate surface. The exhaust air may be turned under the grates, if desired—constituting the four engines, in fact, *blowing cylinders*, to force the fires. Under this blast of warm or hot air, we see no reason why, even with her contracted chimneys, from 3000 to 5000 lbs. of anthracite may not be burned per hour, instead of 500 lbs. The consumption of these engines has been distinctly stated at 500 lbs. per hour, or 6 tons per day, and the greatest possible consumption at 7 tons per day; although the simple fact that this statement was advanced before the ship had run more than 20 or 30 miles altogether might justify a doubt, under any circumstances. The remark that the caloric economy had excelled steam, in the proportion of 5 to 4, which appeared on page 48, was based on a consumption of 500 lbs. per hour, and a speed of seven knots. Several of the steamers on the Hudson River, using a fan-blast, consume as high as 60 lbs. per hour per square foot of grate—a rate of consumption which would raise the Ericsson's expenditure of fuel to 80 tons per day, instead of 6 or 7. At the ordinary rate, without artificial draught, 130 feet of grate would burn nearly 20 tons per day; and allowing liberally for error in our approximation to the dimensions of the grates, a statement of the fact whether the fires were urged, or better still, and more in accordance with engineering usage, an exact account of the coal burned per hour, on any trial trip, should be officially stated, before any favorable conclusion can be arrived at with regard to the caloric engine.

There are two classes of schemes which it comes within our province to elucidate. In the first, we include those which, like the "static pressure engine" and the "fire annihilator," seem designed to be a "speculation" on the ignorance of the public. On the merits of such, the *Mechanics' Magazine* is always ready to take a decided stand, on a careful but brief examination; and if, perchance, at any time, our judgment should be in error, the retraction shall be most full and unqualified. The other class, of which catalized hydrogen, the caloric engine, and various other unsuccessful schemes may be considered types, are deserving of respect as experiments, which, until the contrary is proved, we incline to consider highly commendable efforts towards improvement.

We can see no possible motive which can influence Capt. E. to deception in the caloric engine. The idea of honor or profit, government office, or the like, on the strength of an ephemeral fame, is altogether unworthy of his high and unblemished reputation, and we feel bound to consider the engines of the Ericsson what they are represented to be, the production of a profound and highly educated man, firmly believing in their final success. We confess to a feeling of disappointment in the performance of the Ericsson's engines, and imagine their designer is still more so. We shall hold ourselves in readiness to present any more successful result which may be attained; until which, we consider any discussion on the framing or other arrangements of the engines of little interest.

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MEANING OF THE WORD "CALORIC."—Caloric is another name for heat. Strictly defined, it indicates the principle or matter of heat, and presupposes the belief in a fluid excessively thin and fine, which pervades all bodies, moves through them, and, in proportion as it is present or absent, produces all the effects of heat and cold. In short, if heat is caused by a fluid, caloric is that fluid. This may be considered a distinction without a difference; and, for all practical purposes, caloric may be defined to be heat. Caloric expands air, as, with a few exceptions, it does every other substance, on entering it. Caloric applied to water, expands it to steam; applied to steam, it expands it still more, forming what has been sometimes termed stame. Caloric is the source of power both of the steam and air engines. Both depend on the expansion of matter by heat.

The steam-engine is a caloric engine, for the same reason, and to the same extent, that the air-engine is, except that in both the air-engines of Ericsson and of Stirling the caloric used each stroke is in part retained, and made to serve again. This is sufficient to justify, if any justification were needed, the appropriation of this name to the Ericsson engine. It is simply a distinctive appellation chosen for this particular form of an engine, moved by heat. The choice was certainly a very happy one, and has undoubtedly served to attract much greater attention to this invention than would have been done by the simple name of "air-engine" adopted by Stirling.

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To Readers and Correspondents.

THE indicator card from the engines of the Arctic, given on page 50, presents a somewhat novel appearance, by being traced on a black ground; but is equally clear, and much preferred by the engraver. A full description of the indicator, and arrangements for producing cards or diagrams, will be given at a future time. For the present, it may be sufficient to explain that they indicate the true and effective pressure of the steam, and amount of vacuum at every part of the stroke. The vertical lines divide the whole stroke into feet; and the horizontal lines, with the figures at the side, indicate the pressure in lbs. per square inch on that side of the piston; or, rather, they indicate the difference between that and the ordinary pressure of the atmosphere.

The description of Stirling's air-engine we apprehend to be quite the most important document, in relation to the caloric experiment, which could well be presented. Since having seen the regenerator of the Ericsson, we are of opinion that Mr. Stirling's was, on the whole, *preferable* to that of Capt. E. This is based on the supposition that plates offer much less resistance to the air than an equally fine series of wire screens.

Question 8, on page 70, will require for its solution a tolerable degree of engineering talent. Resistance of the air is to be disregarded. This problem will remain open for two months, unless answered correctly in time for our next number. We would like our friends, old and young, to send questions, as well as answers. Let them be always of some practical importance, and be accompanied in the same envelope by the answer, or, at least, the opinion of the propounder.

In connection with the subjects treated on in "Architectural Engineering," it may not be amiss to allude to a very effective arrangement in the house of an acquaintance, for producing a perfectly odorless privy. So completely is this desideratum obtained, that no offensive smell can be detected, even by placing the face directly in the passage leading to the vault. It is accomplished by simply producing a constant current of air *down* the passages. An extra flue is provided in his chimney, which is warmed by its proximity to the smoke-flues, and connected by a plain wooden box or rectangular passage with the top of the privy vault. The consequence is a perfect ventilation of the vault; the air being drawn down from the privies, and allowed to escape at the top of the chimney. By this means, the formation of carburetted hydrogen, a highly poisonous gas often generated in close vaults, is entirely prevented.

It will be observed, with regard to the "hydrostat," that it is equally applicable to the use of the ordinary engine-pumps—the Worthington, or any of the various devices for self-acting feed, provided they afford sufficient power to overcome the friction, and revolve the shaft *a*. Our artist—one of the best engravers of such work in the country—has excelled himself in the rich "effect" of the engraving.

We propose to commence, in our next, a series of short illustrative essays on mechanical science, practical and theoretical, giving the most approved proportions of the different kinds of engines, tools, framing, mill-work, &c., and a full analysis of the two antagonistic theories of mechanics, which we have before alluded to, as "College" and "Workshop" science.

W. H. S., Conn.—Parachutes have been successfully used in numerous cases. The fatal experiment with which the world have been made so familiar would have undoubtedly terminated favorably, but for some quite trifling circumstances. The late Paris papers give an account of the descent of one Goddard in a parachute, from a balloon, at a great altitude, performing voluntarily all kinds of summersets and rigadoons in the air till it was time to prepare for striking the earth.

J. P. H., Penn.—The article you propose would be acceptable.

"Mechanic," "T. V.," "A Non-Striker," "Builder," and "G. H. R.," are declined.

"An Old Engineer" claims that the Portage Bridge on the Buffalo and New York City Railroad, for which great credit has been accorded to Col. Seymour, the chief engineer, is identical with, if not copied from, the scaffolding used in the construction of the famous "Cascade Bridge" on the New York and Erie Railroad. The latter elegant structure was designed by J. W. Adams, Esq., the engineer of that portion of the road, and late editor of this magazine, and built, we believe, under his immediate direction, by Mr. John Fowler, the contractor; to one or the other of which gentlemen belongs the credit, if any there be, of designing the false work or scaffolding, which, if our correspondent is correct, has been reproduced with too great a flourish in the "Portage Bridge." If this is not the case, we shall be happy to correct the impression.

R. M., Ohio.—There is no "perfect safety" in the use of any of the burning fluids, nor is there in the use of steam, or, in fact, hardly any thing else. Arrangements to promote the safety of parties using these volatile fluids are extremely desirable, and there are many now before the public. We would like to examine your plan. The explosive vapor from these fluids being invisible is the main reason why these are more difficult to manage than gunpowder. It is said to be proved by statistics that more deaths and serious accidents annually occur, from the use of "burning fluids," in the United States, than from steamboat explosions and railroad accidents combined. Professor Silliman is said to have remarked, that if his word were law, there should never be another drop of it used in the ordinary lamps now kept in shops and families.

W. R., Kentucky.—Your communication is unavoidably deferred.

J. Y. R., New York, and W. H. M., Mass., received too late for insertion.

Correspondents, and also those wishing advertisements inserted on the covers, would confer a favor by forwarding, in all cases, as early in the month as possible.

APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 4.—Vol. III.—APRIL 1st, 1853.

WHAT ARE METALS?

[From Overman's Metallurgy.*]

What are Metals?—Chemists denominate as metals those substances which are combustible, that is, which liberate heat in combining with other matter: they assert that metals are good conductors of heat and electricity, and may be polished; are fusible and opake; heavy, malleable, ductile, &c. These are all vague definitions; for not one of the metals answers perfectly to this description. Gold may come most completely within its compass, but if it possesses all the other particulars, it certainly is not combustible in the common sense of the term; while potassium, an equally beautiful type of metal, is extremely combustible, and not heavy. We really do not see any reason why all solid substances which are not oxidized should not range with this class of matter. There cannot be any objection to calling carbon a metal; and we do not see why sulphur is less a metal than selenium or arsenic; why phosphorus is not denominated a metal as well as calcium; both are almost equally combustible, and if phosphorus has no metallic lustre, that is merely indicative that it is not condensed into so narrow a space as calcium. Phosphorus is more volatile than most of the other metals; but no metal is as permanent as carbon, and still the latter is not recognized as a metal. We do not see the slightest objection to calling hydrogen a metal; it possesses almost all the properties belonging to metals. But when matter, gaseous or fluid at common temperatures, is excluded, there cannot be any objection to calling all solid elementary substances metals. Silicon so much resembles a metal in all its properties, that its exclusion cannot be justified, and most philosophers range it with the metals. It is very much questioned whether metals are not compound matter; but as this point does not interest us, we allude to it merely in support of the above pretensions.

In order that we may not appear arbitrary in our classification, we submit to the usual one, and exclude from our investigations all matter which is not considered a metal by common consent.

Instead of describing the general qualities of metals, which we assume to be known by our readers, we insert the following table, which furnishes all the information of this kind which is here required.

Names.	Color.	Specific gravity.	Fusibility.	Malleability.	Volatile at	Decomposing water.	Decomposes
Potassium	gray-white	·865	136°	like wax, brittle at 32°	red heat	any temperature	all minerals
Sodium	"	·972	194°	malleable at 32°	"	"	do. except potassa compounds
Calcium	"			"	"	"	"
Magnesium	white		red heat	"	"	red heat	"
Manganese	gray-white	5·85	high heat	brittle, soft		any temperature	"
Aluminum	white		"	malleable		decomp. air at red heat	"
Selenium	red-brown	4·3	212°	very brittle	red heat	"	
Titanium	red	4·3	infusible	"		"	
Tellurium	gray-white	6·1	600°	"	red heat	"	
Arsenic	gray	5·7	400°	brittle	356°	any temperature	
Chromium	"	5·9	high heat	"		very permanent	
Zinc	white	6·8	770°	malleable	white heat	at 400°	
Cadmium	"	8·6	550°	"	600°	burns in air	
Iron	"	7·6		"	very high heat	at any temperature	decom. the following
Nickel	"	8·2		"	"	"	"
Cobalt	gray	8·5		brittle	"	red heat	"
Antimony	white	6·7	932°	"	white heat	permanent	"
Lead	"	11·3	594°	malleable	"	"	"
Bismuth	white-yellow	9·8	476°	"	"	"	"
Copper	red	8·8	1996°	"	high heat	"	"
Mercury	white	13·5	32°	"	680°	"	"
Silver	"	10·4	2000°	"	high heat	very permanent	"
Platinum	blue-white	21·2	very high heat	very malleable	very high heat	"	"
Rhodium	gray-white	11·	melts in saltpetre	brittle	"	"	"
Iridium	"		high heat	malleable	"	"	"
Osmium	blue-black	10·	"		"	heated in air	"
Palladium	blue-white	11·3	"	"	"	high heat in air	"
Gold	yellow	19·4	2200°	very malleable	moderate heat	permanent	

Classification of Metals.—The number of metals which are regarded as useful, is very limited. But, as many which are of no direct, practical use, enter into combination with those which are generally useful, it is necessary to allude to some of the former, although their interest arises solely from their combination with others. In entering on this part of our work we are under the necessity of classifying the metals in some such manner as shall be useful to the smelter. The most rational classification appears to be founded upon the relation of metals to oxygen, supposing that the reduction of oxides is effected by means of carbon. The number of elements which form minerals is sixty-two, all of which have more or less influence in metallurgical operations. About fifty of these elements are considered metals by chemists, of which nearly half the number are found in such large quantities as to be of importance to the smelter. A large number of metals form slags, as oxides or other compounds, and are hardly known in their pure condition: still these are of high interest, not only because they form slags, but because these slags invariably impart a peculiar quality to the metal which is smelted under their influence. We may, therefore, divide the useful metals into two groups, the one which forms chiefly slags, and the other chiefly metals. To the first division the following belong, viz.: Potassium, Sodium, Calcium, Magnesium, Manganese, Aluminum, Selenium, Titanium, Tellurium, Arsenic, and Chromium. The second group will then consist of Zinc, Cadmium, Iron, Nickel, Cobalt, Antimony, Lead, Bismuth, Copper, Mercury, Silver, Platinum, and the Platinum metals, and Gold.

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* A Treatise on Metallurgy, comprising Mining, and General and Particular Metallurgical Operations. By Frederick Overman, Mining Engineer. Published by D. Appleton & Co., 1852.

All the metals, with few exceptions, are remarkable for a high and peculiar lustre; they conduct heat and electricity better than any other substance. They are considered as opake, but this can be no absolute property, for all metals are porous, and consequently must transmit light when in a body sufficiently thin. The affinity of metals for oxygen is remarkably strong; but under certain conditions, the oxygen is removed by chlorine, sulphur, and other substances. The compounds which are of interest to the metallurgist, are the oxides, carburets, sulphurets, phosphurets, chlorides, arseniurets, silicides, &c. The salts of the metallic oxides are, however, of the most interest,—such as silicates, carbonates, phosphates, chlorides, &c.

Affinity for Oxygen.—Metals are, generally speaking, combustible. They generate heat under the same laws as carbon and hydrogen. It makes no difference in the quantity of heat generated, whether we burn zinc with a pound of oxygen, or carbon with the same weight of oxygen. But, while potassium burns on water, gold must be combined with chlorine before it can be oxydized, that is, its affinity is so feeble, or its body so compact, that it must be dissolved, or divided, into the most minute atoms before it can be combined with oxygen. The metals never combine with any oxydized substance, and least of all with their own oxides, however determined their affinity for oxygen may be. To this rule the exceptions are very few. This is one of the most important peculiarities of metals; and it is the best auxiliary to the smelter. This want of affinity for other substances is the reason why fluid metals appear with a convex surface. The same property is strikingly shown in the refining of precious metals on the cupel; it is the cause of fibres in wrought-iron. The form under which metals most readily oxidize is of high interest; but as it depends upon many circumstances besides affinity, we will point out the means by which they are deprived of oxygen, from which the reverse may be deduced. Metals which are deprived of their oxygen by the mere application of heat, are—Mercury, Silver, Gold, Platinum, Palladium, Rhodium, Iridium, and Osmium; for this reason these are termed precious metals.

Those metals which retain their oxygen at high temperatures, and in fact cannot be reduced by heat only, we shall proceed to enumerate. Of the number, the alkaline metals, Potassium, Sodium, Calcium, and Magnesium, decompose water at any temperature, and retain their oxygen at any heat, while their oxides form alkalies in all cases.

Aluminum and similar metals retain their oxygen, but do not decompose water except at high heats, and form either alkalies or acids.

Nickel, Cobalt, Iron, Tin, Cadmium, Zinc, and Manganese, decompose water at a red heat, and their oxides form either alkalies or acids, according to the matter present, or their state of oxidation.

Lead, Copper, Titanium, Bismuth, Uranium, and Tellurium, do not form acids at high heats, and do not decompose water at any heat: neither does Antimony, Chromium, or Arsenic, but when oxidized, they form invariably acids at melting heats.

The combinations of oxygen and metal take place in certain definite proportions, and, so far as relates to most of the metals in various definite quantities. There is only one oxide of aluminum, but there are three of iron which interest us. The Protoxide of iron is a strong alkali, the magnetic oxide a feeble alkali, and the peroxide is more of an acid than an alkali. Peroxide and protoxide of iron, both infusible by themselves, form a fusible slag, or glass. Arsenic forms in all stages of oxidation an acid, which never melts together with another acid, or a highly oxidized metal. The electro-positive or negative character of an oxide, is, however, no condition required for its fusibility; for litharge and lime, both strong alkalies, melt together and form slag. But it is always a requisite condition that one of the constituents must be fusible, in which the other is merely suspended. The chemical relation is by no means limited, that is, one and the same substance is not always, nor in all relations, of the same character. The oxides of iron are always alkalies with silex, but they are acids in relation to oxide of lead. Alumina is an alkali in the presence of silex, but an acid when in contact with the alkalies proper. The study of the metallurgist must be directed to these chemical relations, and chiefly also to the degree of fusibility of these compounds, and the relation which they bear to the metal to be produced under their influence. As a rule, we may state, that the compounds of single equivalents of metals and oxygen always constitute a base, or alkali, and that any more oxygen destroys that property. Thus, the protoxide of manganese, Mn O, is a strong basis, and precipitates the protoxide of iron from a slag, or any compound; but the peroxide of manganese, Mn O_2, is driven out by the protoxide of iron. When carbon is present, one atom of oxygen is absorbed by it, from the peroxide of manganese, and the iron is again driven from its union.

Hydrated Oxides.—The oxides also combine in certain proportions with water, and form definite compounds, called hydrates. These combinations are not only of interest so far as they form the most porous and best kinds of ore, but the tenacity with which water adheres to some of the hydrates is remarkable. Potash, clay, and silex retain their water at an almost red heat, and the first may be actually melted without losing all its water.

The degree of affinity of oxygen for metal is the strongest, and is most difficult to destroy at a medium state of oxidation between the highest and lowest. Protoxide of tin is easily converted into metal, so is peroxide, but the sesqui-oxide, a combination between, or of, the two, cannot well be reduced to metal without evaporating the largest part of the metal. In practical operations we always endeavor to smelt the highest oxides, and convert the ores into them, in case they are not naturally in that state. The reasons for this, are the following: In reviving metals from their ores, it is not only the object to remove the oxygen from the metal, but also to produce so high a heat as to melt the metal at the precise moment when the oxygen is removed. If only little oxygen is combined with the metal, it is evident that but little heat is produced; the metal may be in the proper form, but it cannot accumulate into a body, and the least amount of oxygen will oxidize it again. If the quantity of oxygen is large, a proportionate amount of carbon will be consumed, and the heat will be higher than when there is less oxygen with the same amount of metal; the metal will now melt, agglutinate, and in that form resist the influence of oxygen successfully. This law is apparent in most cases when smelting is done on a large scale, but particularly so in smelting refractory metals,—such as iron, manganese, chromium, and others. Lead may be smelted in either form, because the metal is very fusible, but less lead is evaporated in smelting minium than litharge or galena.

Affinity for Chlorine.—Chlorine has a peculiar tendency to induce metals to crystallize; it causes fluidity and brittleness. The affinity of chlorine for metal surpasses that of oxygen, and drives out the latter in all instances. It cannot be removed by carbon, but it sometimes may be by hydrogen, as in the case of gold, silver, copper, lead, and mercury. The energetic connection between chlorine and metals would be an impediment to working ore, in which even a small amount of it was present; but all chlorides are extremely volatile and easily driven off. Still there is always an indication of the presence of chlorine in those metals which have been smelted from ores containing it. Chlorine removes all other matter from metals when the latter are in a state of fusion; carbon, sulphur, phosphorus, and other volatile matter is driven off by it, and, if the heat is continued, the chlorine itself escapes at last with a portion of the metal. This is the case when only a minute amount of it is present. It is, therefore, one of the most powerful means of purifying metals. Lead smelted from chlorides, or only from a mixture of chlorides and other ore, is always purer than that from oxides or sulphurets. The proper application of chlorides has a most beneficial influence on smelting and refining operations. Zinc does not combine very readily with iron, but if some chlorine is in it when melted, the operation is performed with the greatest ease. Chlorine has a remarkable tendency to combine with metals, and is particularly distinguished for removing oxygen from the peroxides; it, therefore, purifies the surfaces of melted metal, and causes those in an alloy to unite closely. This is not only the case with different metals, but also with any one in which there is chlorine.

Chlorine is not decomposed by any heat, or other means; it is, therefore, always present in its pure and proper form, and we may depend upon removing it finally by the continuation of heat only. All metals which have been smelted under the influence of chlorine are remarkably inclined to oxidize so long as it is not entirely removed.

It is a harmless substance to the metals; and as it is a powerful means of fluxing ore and slags, and causing metal to be fluid, its use ought to be more extended than it is at present. So long as volatile substances are combined with a metal, very little or no chlorine escapes; but after sulphur, phosphorus, and similar matter is driven off by it, chlorine itself escapes—first with arsenic, then tin, antimony, mercury, zinc, and iron. We may therefore regulate the refining of metals under the influence of chlorine, according to the volatile character of the substance to be removed; observing due regard to the degree of affinity between chlorine and that substance. Some chlorides escape in their proper form, such as those of arsenic, tin, and antimony; others are decomposed so soon as they are liberated and atmospheric air or steam has access, as chloride of iron, aluminum, and silex, which are converted into oxides and hydrocloric acid. All evaporated chlorides may be recovered by condensation; they are precipitated at a temperature a little higher than that at which steam condenses.

Iodides, bromides, and fluorides, are similar in operation to chlorides; but as they are not so plentifully met with as the latter, they are of little interest to the smelter.

Sulphurets.—All metals combine more or less vividly with sulphur, which combination is, in all cases, destroyed by oxygen or chlorine, with the assistance of heat. Sulphurets are formed when sulphur is brought in contact with hot metal, provided no oxygen or chlorine is present. When oxides are heated with sulphur which so far predominates as to absorb all the oxygen in forming sulphurous acid, the remaining sulphur will combine with the metal. When sulphates are heated in the presence of carbon or hydrogen, the oxygen of the sulphuric acid is abstracted, and sulphurets remain. Sulphuretted hydrogen, when conducted over oxides, or over red-hot metal, forms sulphurets. A hot, or fluid metal, which contains only a small amount of chlorine, does not absorb sulphur. The chemical relation of sulphur to metal is similar in respect to quantity, to that of oxygen; that is, the number and equivalent composition of the sulphurets, correspond with the number and equivalent of the oxides, of the respective metals. Sulphur causes metals to be more fluid, and brittle when cold, and, in most instances, imparts to them a pasty condition which impairs their ductility when hot. A large quantity of sulphur causes a low degree of fusibility in metals, which is shown most distinctly in the sulphurets of antimony, lead, copper, and iron. This fusibility decreases more rapidly than the evaporation of sulphur. Iron pyrites melt at a very low red heat; but when the quantity of sulphur is reduced by evaporation to half the original quantity, it requires a strong white heat to melt the sulphuret. This fusibility of the sulphurets is, in many instances, judiciously applied in the formation of a fluid slag. For the removal of sulphur from metals, the presence of free oxygen or chlorine is required; it is, therefore, of no avail to melt metal which is adulterated with sulphur, under an alkaline slag, because no slag will absorb sulphur from a metal until it has itself been converted into sulphuric acid. Sulphur cannot be removed entirely when carbon is present, or hydrogen, or any reducing agent; it requires an oxidizing influence, and a thorough exposure of the metal to oxygen. Sulphurets may be reduced by means of metals which show a stronger affinity for sulphur than those in combination with it. The sulphurets of copper, lead, antimony, and others may be reduced by iron, but we never thus obtain pure metals; the newly-formed metal is either adulterated by the absorbent, or by sulphur. Instead of metals themselves we may employ the oxides, particularly the peroxides, finely powdered and mixed with carbon. Sulphurets of antimony, silver, and bismuth, may be reduced by means of hydrogen, but no other metals.

Phosphurets.—Phosphorus combines readily with most of the metals, and adheres tenaciously to them. The combination is readily formed when phosphates—the form in which it is generally found in the ores—are heated in the presence of carbon; and as the latter is always used in smelting operations, we may reasonably expect phosphorus in any metal which is smelted in the presence of phosphoric acid, and carbon or hydrogen. Therefore the presence of bones, or bone ashes, in an ore or in a slag, will cause the metal to contain phosphorus. The best means for forming a phosphuret is, to heat a phosphate in the presence of carbon. Phosphorus is more easily oxidized than sulphur, and combines in this condition readily with alkalies and alkaline earths; we may, therefore, by these means, remove phosphorus. It also causes metals to be very fusible, more so than any other substance, but disposes them to be brittle when cold.

Carburets.—Carbon has only a feeble affinity for metals, and cannot readily be combined with them. But, in most cases, the metals when reduced from porous oxides, in the presence of an excess of carbon, absorb some of it, and condense it in their pores. It is doubtful if a chemical combination is formed; still, there are indications of legitimate compounds under certain conditions. The best means of forming carburets are the carbonates, and oxalates, heated in the presence of carbon. The crude iron obtained from the smelting of sparry iron ore, may be considered a real carburet of iron. Carbonate of lead, when reduced by means of carbon, forms also a carburet; but this is less distinct than that of iron. In consequence of the faint affinity of carbon for the metals, they are generally very brittle when the amount of it is large. But when a small amount only is mixed mechanically with metal, as is the case in gray cast-iron, its strength is not much impaired. The combinations of carbon and metal are more fusible than pure metals; and as carbon is easily removed from metal by oxygen, it is one of the best means to cause metals to be fusible.

Alloys.—We shall not here enter fully into the peculiarities of alloys—which shall be done under the particular metals—but we will point out some of their general characteristics. The metallic elements do not, at first sight, appear to combine in certain ratios and form definite compounds: still, it cannot be denied that some metals do; and we are justified, by the general law of affinity, in assuming that all metals combine chemically. We succeed always in melting various metals together, but we do not very often succeed in separating the excess of any one. The cause for this may be either the volatility of one, or more, metals in the alloy, or the refractory nature of another. As a general rule, we may state that all the metals which form alkalies have a particular tendency to unite with those which form acids. Potassium combines readily with antimony and arsenic, more so than with other metals. In considering the nature of protoxides, in their chemical relations, we may successfully form a series in which the ability of metals to combine is represented. This accounts for the peculiarities of the alloys of selenium, arsenic, antimony, and tellurium; which resemble very much the combinations of metal and sulphur, or phosphorus, or chlorine. All these substances form acids in their most simple combination with oxygen. Alloys and compounds of this kind are peculiarly inclined to be brittle and fusible. When two metals are near in the series of affinities for oxygen, they do not combine very readily; and they may often be separated by crystallization only, when their degree of fusibility is sufficiently distinct. This happens when both metals absorb the same, or nearly the same, quantity of oxygen in forming oxide. All chemical combinations liberate heat; silver and platinum, when melted together, produce a high temperature; so do zinc and copper. In most cases, we obtain a mere mechanical mixture of metals in an alloy; this is always characterized by forming distinct crystals with one metal, between which the other is visible. When an alloy is formed, which contains equivalents, no such disconnected crystals are observed. An irregularly composed alloy is a mere mechanical mixture, like wax and fat, and never forms a uniform body of metal; it is of either a granulated or crystallized texture, the latter of which is not compact. Between the crystals of such an alloy, one of the metals is always found in a nearly pure condition. The alloy of iron and silver, in which the silver is mechanically inclosed between the crystals of iron, is an instance of these compounds. Lead and tin combine in certain proportions, and whatever excess there may be of either material, it is inclosed between the crystals of the alloy. The same is the case with zinc and tin, bismuth and tin—and in fact, with all other metals. The number of definite compounds appears to be very large, and in all cases, a metal is never obtained pure, whenever another is present. In cooling a melted alloy, that composition which is most refractory crystallizes first; and that which is most fluid, is compelled to occupy the spaces between the crystals of the most refractory. Thus, copper and tin are very fusible; but in cooling, copper-tin crystallizes first, and tin-copper last—which latter occupies the spaces between the first. Iron and arsenic are very fusible, but in cooling, iron-arsenic crystallizes first, and arsenic-iron last; the surface of the cooled mass shows a perfect network of bright lines, in regular forms. In all these compounds the first crystallized metal, or alloy, contains some of the latter, and the latter some of the first. When a bar of cold lead is held in mercury, the first absorbs some of the latter, throughout its body; the pores of the lead are filled with mercury—but the mercury in this case contains lead, as well as the lead mercury. When iron is gently heated imbedded in carbon, as is the case in making blistered steel, the carbon penetrates the very heart of the iron-rods; but no iron is imparted to the carbon, because its particles are not movable. By these and similar means the pores of a refractory solid metal may be filled with another metal, provided the atoms of the latter are movable. Lead does not readily combine with iron, but if we heat wrought-iron turnings in melted lead, the solid iron will absorb lead. Gray cast-iron will not absorb lead, because its pores are filled with carbon. Borings of cast-iron absorb arsenic readily, when imbedded in arsenious acid and heated; but wrought-iron does not absorb arsenic by these means until carbon is brought in contact with these substances. In properly applying these rules, we may form alloys of the most heterogeneous metals, and in legal proportions. It is extremely difficult to form a definite compound of zinc and copper, or tin and copper; but if we take either the oxides of all these metals, or the oxide of any one, and the metal in small particles, and imbed the whole in carbon—heating it so as not to melt it, although bringing it near its melting point—and then apply the heat gradually and slowly, we are enabled to form definite compounds, which may be melted by a heat which does not evaporate either the one or the other metal. We shall point out the formation of alloys by metals directly, in subsequent pages; but we wish to draw the attention to these facts, because it is often very difficult to form an alloy of a definite composition. Yet as these alloys are the most valuable, we refer to the above mode of forming them.

Fusibility of Alloys.—Alloys are more fusible than the mean temperature, at which the metals melt singly, would indicate. This is a very important law in our investigations, and affords, when properly applied, the most valuable results. When tin melts at 500°, and pure copper at 2500°, equal parts of copper and tin do not melt at $\frac{2500 + 500}{2} = 1500°$, but at a lower heat. Platinum, and also chromium, are infusible in our furnaces, but may be made very fusible by the addition of arsenic. Pure iron is extremely refractory, but when combined with arsenic and phosphorus, it may be melted in a cast-iron pot, without adhering to it. Thus, when an alloy of two metals is fusible at a lower heat than the mean of the two, a composition of three metals is still more fusible than their various degrees of melting indicate; and by multiplying the number of component parts a low degree of fusibility of any metal may be obtained. If the composition is according to the laws of chemical affinity, the melting point is lowest. In all cases of practice we must reflect on the application of the metal, before we form an alloy, the object of which is to facilitate the smelting operation. If phosphorus causes iron to be very fusible, and coal, flux, and labor may be saved in smelting bog ores which contain phosphorus, the first inquiry must be whether the cold-short iron thus obtained is of any value. Arsenic and zinc cause lead and silver ores to be easily melted, but the loss in silver by this operation is so great as to make it desirable to remove these volatile metals before any smelting is entered upon. We may flux copper by arsenic, but not by lead, because we can remove the first in refining, but not the latter sufficiently to form a good quality of copper for sheets. Arsenic, lead or zinc, may be in iron which is destined for wrought-iron, for these metals are easily removed in the refining process. It is always more safe in smelting gold ores, to have lead, copper, or silver present, and if possible all of them; for, gold is very volatile and extremely divisible, hence much of it may be lost when no other metals, which act by their quantity, are present. Lead fuses at 600°, tin at 500°, and bismuth at 400°; but a composition of the three may be made which melts at 212°, a heat far below the most fusible of the ingredients. This shows how great the advantages are which may be obtained by forming alloys in the smelting furnaces. It is the degree of fusibility of the slags and that of the metals, which determines the expenses of smelting. The number of alloys is infinite. We cannot establish tables of fusibility *a priori;* these must be determined by practice. In all smelting operations it is necessary to find the most profitable conditions by experiment.

If an alloy is more fusible than a single metal, it follows that, when one or the other constituent is removed, the fusibility of the metal is impaired. An alloy of lead and arsenic is more fusible than pure lead; but when the alloy is exposed to heat for a long time, arsenic will evaporate; and as it was the cause of fluidity, the lead will not be so fusible after losing its flux. Iron is made fusible by the presence of carbon or other substances, but when these are removed, it is very refractory, and can hardly be melted. Upon this principle the formation of wrought-iron is founded; and in applying it to other metals there is no doubt but similar results are obtained. Tin is refined by oxidizing or evaporating sulphur, arsenic, and other matter; this causes the tin to be less fusible, but more tenacious. When zinc is melted in an iron pot, and exposed to the air, it forms dross on its surface like other metals; its fluidity is consequently diminished, but its malleability is improved. A layer of carbon, or, what is still better, a layer of common salt, or bone ashes, prevents such phenomena with zinc and similar metals.

Specific Gravity.—When metals are melted together and form an alloy, there is produced a remarkable change in their specific gravity; which is sometimes greater and at other times less than the mean. A condensation of volume is manifested in melting together zinc and gold; the specific gravity of the compound is greater than the mean of the constituents; gold also and silver condense, or gold with lead or bismuth, silver combined with copper, lead, tin, bismuth, and zinc or antimony shrinks; also copper with tin, zinc or antimony; lead with zinc, bismuth or antimony; mercury, with tin or lead, bismuth and antimony. An expansion takes place when gold is melted with copper, iron, or tin; also platinum with copper; iron with antimony, bismuth, or tin; also copper and lead; tin and zinc, lead or antimony; zinc and antimony, and mercury with bismuth. In consequence of this contraction or expansion we are justified in assuming a similar change in the aggregate form.

The hardness of alloys is generally greater than may be inferred from the nature of the constituents, still there are exceptions to this rule. Silver or arsenic renders iron hard; but these metals are soft by themselves; copper and tin, two very soft metals, may be made extremely hard by melting them together in certain proportions. Hard zinc and copper make soft brass, and a compound of lead and iron is extremely soft. Antimony causes all metals to become hard; iron, with a little antimony, cuts glass very readily, but is very brittle.

The ductility of alloys is in some cases greater than the elements indicate; that of lead and zinc is very tenacious. In most instances the alloy is more brittle than the original metals. Lead and antimony is very brittle. Two or more brittle metals melted together are always brittle. A compound of lead and gold is very brittle. There is no precise limit at which we know when brittle or malleable alloys are formed; it is necessary to find this by practice; but there are strong indications that the alloy of an equivalent composition is always harder than a mere mechanical mixture of metals. Any alloy, when slowly heated and gradually cooled—annealed—is softer than a compound which is suddenly chilled. In annealing, the various elements which are in combination endeavor to separate. Heat here, as everywhere, weakens affinity. This causes a finely crystallized, or a granulated f[illegible]cture; the component particles endeavor to assume a round form. When a hot alloy is suddenly chilled, the particles of which it is composed contract suddenly and form a close compact body; at least the ultimate crystals are condensed into the smallest space, which causes them to be hard. This is most strikingly exemplified in some kinds of iron.

Any kind of iron in market may be considered an alloy; there is no such thing as pure iron. Some wrought-iron contains much foreign matter, and still is soft as lead, and fibrous. If such iron is heated to a certain degree, that is, beyond the degree at which it has been manufactured, it becomes cast-iron, is brittle, and when suddenly chilled becomes hard, similar to steel. Such iron may be annealed and softened like steel, or any other alloy. The hardness of an alloy is therefore less dependent upon its composition than upon the arrangement and form of the ultimate particles. We shall refer to this subject again at the end of this chapter.

Oxidation.—Alloys oxidize more rapidly than single metals; to this rule there are, however, remarkable exceptions. Hardened or crystallized metal oxidizes more rapidly, than tempered or annealed metal, which is most strikingly exemplified in iron and steel. It appears that metals expand on being suddenly chilled. The spaces thus formed between the crystals are fissures into which oxygen may penetrate with facility, and as the crystallized form of the particles affords much surface for combination, an oxidation is readily effected. An alloy of antimony and iron, two metals which are remarkable for crystallization, oxidizes very readily; such an alloy may be ignited by mere filing, particularly when it is a little heated previously to that operation. Chrome and lead act in a similar manner. Antimony and potassium burn spontaneously, and if a little warm, with explosion. An alloy of tin and lead—soft solder—burns with a vividness equal to carbon, and if some zinc is present, only a low heat is required to ignite the mixture. An amalgam of potassium and mercury is so sensitive to oxygen that the mercury is oxidized to a high degree. In many cases, and under peculiar arrangements, the oxidation is carried to the highest degree: we have seen that in roasting sulphurets, phosphurets, and other compounds, the metal is always oxidized to the highest degree. The same cause acts in both cases. When two or more metals are melted together, there is a perfect penetration of the one by the other. In heating the mass, the tendency to separation is augmented, and as the ultimate particles of one metal cannot congregate and form large particles, they are exposed to the action of oxygen in their minutest form, and consequently will combine with the largest quantity of oxygen. If one kind of metal is more oxidizable than the other, or if the mass is porous, the oxidation goes on, not only faster, but, must proceed to the highest degree because the atoms of metal may be attacked by oxygen on all sides. While some alloys are easily oxidized, others resist that influence more than pure metals.

Pure iron is very easily oxidized, and often throughout, when in heavy masses. A lot of bloom four inches thick, of puddled iron, was oxidized in a re-heating furnace by giving merely a drawing heat to such a degree, that when drawn out between rollers into bars, these were found to be converted partly into magnetic, and partly into protoxide of iron. This iron was puddled under the influence of a cinder highly charged with chlorides. Metals are porous, and easily penetrated by other matter. Thus water enters successfully into the body of cast or wrought iron; and if a metal is present, or any other substance which decomposes water, the iron is easily oxidized. We find, when carbon is present, that oxygen has little effect on iron; but when any of those substances which form acids, such as arsenic, antimony, or sulphur, are combined with the metal, it is an easy prey to oxygen. An alloy of chromium and iron resists oxygen as well as gold; and phosphuret of copper is not so easily affected as pure copper. Bronze will resist the influence of oxygen much longer than pure copper.

This subject of oxidation is of much practical interest, and deserves more attention than has been paid to it by metallurgists. It seems that no definite rules can be applied; so far as we know, nothing is settled respecting it. It appears, that the degree of affinity has less influence on the oxidation of metals than the aggregate form of their particles, and the strength of their union. Hardened steel oxidizes more readily than annealed steel, and chilled cast-iron more so than gray cast-iron. Hammered or rolled lead is less penetrable by mercury than cast lead. German silver, which is composed of oxidizable metals, is little affected by oxygen, and less so when rolled than when cast. Copper has a strong affinity for sulphur, and is more readily attacked by it than iron, when finely divided; yet, when in a compact body, it will resist that substance far more successfully than iron. Some kinds of brass are remarkably liable to oxidation, while others resist it more effectually. A surface of metal which is highly polished. and particularly when polished by rubbing it with a hard substance, is far less subject to oxidation than a rough surface. If it is desirable to resist oxidation, or in fact the influence of any other matter upon metal, those alloys must be formed which have naturally little affinity for that particular substance, and which, in the mean time, form the most intimate union, so that the penetration of foreign matter into the body of the metal is prevented. It is not the compactness of zinc or lead which prevents their oxidation in the atmosphere; it is the cover of oxide, which forms a close body, and prevents the further penetration of oxygen. We may assert that the density of gold and silver has as much influence in preventing their oxidation, as their want of affinity for oxygen. Affinity between the metals of an alloy has, in consequence of an intimate union, a large share in preventing oxidation. Iron is easily oxidized, but it is less subject to that influence when combined with phosphorus than when alloyed with silver or gold, particularly the former; this is chiefly because silver has but little affinity for it, and is thus excluded from its crystals, and forms a layer between them. There is a separation; oxygen finds access, and a rapid action of it is the consequence. Carbon protects iron successfully, not in consequence of its greater or less affinity for oxygen or iron, but chiefly on account of its form. Carbon is elastic, and will fill the spaces between the particles of metal. When gray or white cast-iron contains five or six per cent. of carbon, the latter will form a body, when liberated, which cannot be condensed into the same space again by any mechanical means; and even in the form of graphite, it occupies nearly the space of the iron. Still, cast-iron is porous. All substances foreign to iron, which are contained in the finest kind of cast-steel, cannot, when liberated, be condensed into the same space which they occupied in the steel; and such steel, when glass-hard, is very porous; there is not even cohesion between its particles; it is brittle. In this may lie the apparent secret of hardness.

Every alloy, as far as regards utility, may be considered a new species of metal, because the qualities of the constituents are, in most cases, not recognized again in the compound; it shows properties which do not belong to the simple metals, and which cannot be determined by theoretical speculations. By changing the proportions of tin to copper, we obtain bronze of different qualities, varying extremely in color, hardness, and sound. All the alloys of tin and copper are harder than either element, and half and half is as hard as steel, but extremely brittle. A few per cent. of tin causes copper to be hard, and more tenacious. The addition of a little lead causes brass to be more ductile, while a large addition makes it brittle. Silver is rendered hard by the addition of a little copper, while copper is more tenacious in combination with a little silver.

[From the London Mechanics' Magazine.]

On the Calculations used in Measuring the Stability of Ships.

BY DR. WOOLLEY, PRINCIPAL OF H. M. SCHOOL OF NAVAL CONSTRUCTION, PORTSMOUTH.

THERE are now two different ways of considering the qualities of a ship as regards stability, and therefore two different modes of expressing it. The former of these we owe to the French writers of the last century, who taught us to regard a vessel as more or less stable according as the moment of the force which acts to bring it back to its original position, after it has been displaced, is greater or less. They contented themselves, it is true, with calculating this moment for very small angles of inclination. Attwood afterwards extended this method to angles of finite magnitude.

The second or dynamical measure of stability, which we owe to Professor Moseley, is the number of units of work necessary to incline the vessel through any angle. This is, of course, equivalent to the total effect of the forces which have been in operation in producing this inclination during the whole time of the vessel's moving from one position to the other. And, since a sudden gust of wind or blow of a wave generates a certain amount of *vis viva* in the ship, which must be overcome by the forces which resist the inclination, it is evident that the work done upon the vessel by the fluid pressure from the position of rest to the extreme position of inclination, is a proper measure of the work done by the gust of wind or the blow of the wave. The chief use of calculating dynamical stability is, to insure the ship from danger under such circumstances: if, therefore, a vessel whose form and qualities are well known has been ascertained to roll through a certain angle, say from 25° to 30°, in a violent storm, and this angle be taken as the limit to which a vessel may incline without danger, the designer should take care that the vessel he proposes should have at least an equal amount of dynamical stability for that angle of inclination.

Hence dynamical stability must be calculated for a very considerable angle.

Statical stability is an element of the utmost importance for all ships—for a vessel deficient in it cannot be very weatherly; neither could it, if a vessel of war, be able under many circumstances, to use its lower guns, where a vessel of more stability would have this power, and therefore have a decided superiority over the former. It insures that, for a given amount of canvas and force of wind, the vessel should not incline beyond a certain angle. It is usual for vessels of war to calculate that moment for an angle of 7° or 9°, and then to provide that the ratio of that moment to the area of sail should lie within fixed limits, which have been practically found to be the best, varying with the different classes of ships.

Both of these measures of stability may be made to depend on the determination of the rectangular co-ordinates of the centre of gravity of displacement corresponding to the extreme inclination of the ship. If a ship were of a geometrical figure, the locus of these centres might be geometrically determined and laid down, and used as the basis of our calculations. The ship's surface is, however, generally of an irregular form, and the method for finding this locus approximately, at the same time gives the calculations we require for the stability. Thus, in Fig. 1, let AVB be a transverse section of the ship (made by a plane perpendicular to the fore and aft line) containing the centre of gravity of the ship G and centre of gravity of displacement H. And let AB be the section of the load-water line—that is, the line in which the plane of flotation, when the vessel is upright, cuts the ship. Suppose, now, the vessel inclined in the vertical plane ABD, through angle ASC$=\theta$, and let CSD be the inclined water-line, and P the corresponding centre of gravity of displacement, or rather its projection on AVB; *g* the centre of gravity of the volume contained between the water-lines AS SC and the ship's side, which is carried out by the inclination, to which we will, following Dr. Inman's nomenclature, give the name of *out;* and *h* that of the corresponding volume which is carried under, and which we call the *in; mg, nh,* perpendiculars on CD; PZ also a perpendicular from P on CD; HQ, GZ, perpendiculars on PZ, and therefore parallel to CD; GR parallel to PZ, meeting HQ in R. Let Mθ be the moment of the force that acts to bring the vessel back to the upright position—that is, its statical stability.

And Nθ the number of units of work which have been done on the vessel during the inclination through the angle θ—that is, its dynamical stability.

In the inclined position, CD is horizontal; and, since the vessel is acted on only by its weight and the fluid pressure, which equals the weight of vessel, and acts upward vertically through the centre of gravity of displacement;

$M\theta$ = moment of force to restore the vessel to its position.

$= W.GZ$ (W being weight of ship).

$= W.HQ - W.HR = W.HQ - W.GH \sin.\theta$ . . . (1)

And $N\theta$ = Work done by gravity and fluid pressure during the inclination.

= Work done in producing the total *vertical* separation of the centres of gravity of ship and displacement.

$$= W(PZ - GH)$$
$$= W.PQ - W.GH + W.QZ$$
$$= W.PQ - W.GH \text{ Vers. } \theta. \quad . \quad . \quad . \quad (2).$$

Now, if PN be drawn perpendicular on VHG, it is easily seen that

$$HQ = PN \cos.\theta + HN \sin.\theta$$
$$PQ = PN \sin.\theta - HN \cos.\theta\text{; and therefore}$$
$$W.HQ = W.PN \cos.\theta + W.HN \sin.\theta$$
$$W.PQ = W.PN \sin.\theta - W.HN \cos.\theta.$$

Hence we see that all the calculations can be made to depend on finding the values of W . PN and W . HN.

Let w = the weight of the fluid displaced by the *in* or *out* (since they must be equal).

Draw $m'g$, $n'h$, perpendicular from g and h on AB.

Then, by a well-known property of the centre of gravity,

$$w.m'n' = W.PN \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (A)$$
$$w.(m'g + n'h) = W.HN \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (B)$$

The centre of displacement does not necessarily lie in the plane AVB. Suppose, then, that a and a' are the distances of centres of gravity of *out* and *in* from plane AVB, and x be the distance of centre of gravity of displacement P from the same plane.

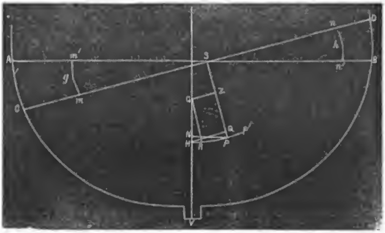
Then $Wx = w(a' - a) = wa' - wa$ . . . . (C).

This calculation it is as essential to make as the two former, because the centre of gravity of displacement ought not to travel much, if at all, out of the vertical plane AVB; for if it does, the axis about which the vessel moves would be continually changing its direction, and a very complicated and disagreeable motion would result.

If a and a' have different signs; that is, if the centres of gravity of the *in* and *out* travel one towards the stem and the other towards the stern, it is evidently impossible to make x vanish; and, under these circumstances, it would attain its greatest value. But if they travel in the same direction; that is, both towards the stem or both towards the stern, $a' - a$ may be made very small, and even vanish. This it should be the aim of the naval architect to effect.

The advantages of a general uniformity in the calculations used in naval architecture are so obvious, that it is unnecessary further to dilate on them. In the case of statical stability, Dr. Inman proposed a method by drawing radii from S (the intersection of the planes of flotation) to the ship's sides, which compensated by its simplicity for its want of uniformity with the other rules. This is only applicable, however, to comparatively small angles of inclination. To extend it to more than three radii, which considerable angles would require, would be tedious and complicated.

Fig. 1.



Attwood proposed in each case to measure ordinates parallel and perpendicular to CD, the inclined water-line for the whole ship, and apply the very same rules as for the upright position of the ship. This is evidently tedious. The method now proposed consists in taking the original load-water line AB as the basis of all calculations, and performing them with as little departure as possible from the common rule.

Let the ship be divided into any even number of slices by planes parallel to ADB, both fore and aft, separated by a common interval m.

Fig. 2 represents the projections of these sections, numbered 1, 2, 3, &c., for the fore-part of the ship projected on the plane ADB.

From C, where SC cuts the section 1, draw CM perpendicular on SM (a vertical line through S); divide SM into any number of equal intervals: four will be generally sufficient for the greatest angles; two will suffice in many cases—and from the points of division draw ordinates parallel to ASB to the section 1. These are the lines a_1, a_2, a_3, a_4, a_5, in the figure.

The area ASMC may be calculated by the ordinary rule, viz.:

$$\text{Area} = \frac{m}{3}(a + 4b + 2c),$$

where a = sum of first and last ordinates,

b = sum of even ordinates,

c = sum of all the odd ordinates, except the first and last, and

m = the common interval.

Generally suppose the number of ordinates $2n + 1$ and the interval l.

$$\text{Then area } AS_1C = \frac{l}{3}\left\{a_1 + a_{2n+1} + 4(a_2 + a_4 + \&c. + a_{2n}) + 2(a_3 + a_5 + \&c. + a_{2n-1}\right.$$

and area of $\triangle SMC = 6\frac{1}{2}\, SM \times SC = nla_{2n+1}$.

∴ Area ASC = area ASMC − △SMC = A_1 suppose. Similarly by drawing DM parallel on SM', and proceeding in the same way, we may find area BSD = B_1.

From C_2, where the second section 2 is crossed by SC, draw C_2M_2 perpendicular on SM; divide SM_2 as before into as many even intervals as may be convenient, and proceed to calculate the area AS_2C_2 as before, and find in the same area B_2SD_2; and so on for all the other sections.

Then, using A_1, A_2, A_3, and B_1, B_2, B_3, &c., for ordinates of two curves separated by common interval m, we may, by Simpson's rule, find the volume of the *out* and *in* for the *fore*-part of the ship. Proceed in the same way for the volume of the *out* and *in* aft.

Let O and I be the whole volumes of the out and in thus found. Then O ought to be equal to I; if it is not, it arises from the point S being wrongly chosen. Before proceeding with any other calculations, the proper position of this must be found. Let S' be that position. Draw C' S' D' parallel to CD.

Then volume on base AS' C' = volume BS' D'.

Volume AS'C' = volume ASC + prism on base CSS'C'.

Volume BS'D' = volume BSD − prism on base DSS'D'.

Hence O — I = prism on base CDD'C' = area of inclined load water-line CD × SS' sin. θ nearly. Whence

$$SS' = \frac{O - I}{\text{area of inclined water-line.}} \times \sec.\ \theta.$$

The point S being thus accurately found, we may proceed with the other calculations.

For section 1 multiply $a_1, a_2 \ldots a_{2n+1}$ by $o \times l, l, 2\,l, \ldots 2nl$ respectively, and use the products so found for ordinates of a curve with common interval l; this gives the moment of the whole area ASMC with respect to plane AB.

But the moment of the △CSM with respect to the same plane

$$= nl \times a_{2n+1} \times \frac{4}{3}\,nl = \frac{4}{3}\,n^2l^2a_{2n+1}.$$

Subtracting this from the moment before found, we get the moment of the area ASC about AB.

Also squaring

$$a_1, a_2 \ \ldots \ldots \ a_{2n+1}$$

and taking one half of the squares for ordinates with common interval l, and, summing by Simpson's rule, we obtain the moment of area ASMC, about the vertical longitudinal plane through S. Moment of the △SMC about the same plane

$$= nl \times a_{2n+1} \times \frac{1}{3}\,a_s = \frac{1}{3}\,nla^2_{2n+1}.$$

Subtracting this from the former, we get the moment of area ASC about plane SM. Proceed in the same way for the moment of the area BSD; and also for all the sections, 2, 3, &c., to the foremost one: we then get, by addition, the moments of the wedges on bases ASC, BSC for the fore-part of the ship, with regard to the horizontal and longitudinal planes. Proceed in the same way for the aft-part, add together the moments of both *in* and *out* for the vessel to each plane, and multiply the whole by weight of a cubic foot of water.

The first sum = moment of in and out with regard to plane AB.

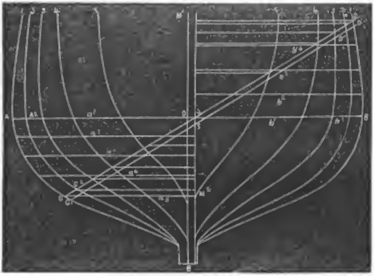
$$= w(gm' + hn') = W.HN,$$

and the second sum = moment of in and out with regard to longitudinal plane through S.

$$= w.m'n' = W.NP.$$

The rule derived from this method is very evident. It would be well in every calculation to make a table of ordinates and squares of the ordinates for each transverse section, both for the *in* and *out*, and place above it the common interval for that section, which, it will be observed, varies for every section, as also for the *in* and *out* in each section.

Fig. 2.



The calculations would, of course, be easier if those common intervals were equal, or were in some proportion; but this cannot generally be the case. This makes the calculations somewhat tedious; but then it must be remembered that for each section the number of ordinates is small, which renders the application of the rule so far easy and simple.

To finish the calculations, multiply the areas A_1, A_2, &c., for the *out* by 0, m, $2m$, &c., respectively, and, using these products as ordinates and common interval m, apply Simpson's rule: the result is, the moment of the *fore out* with regard to plane AD B. In the same way, find the moment of the *aft out* with regard to the same plane.

Then moment of *fore out* — moment of *aft out* = moment of whole *out* with respect to plane AD B = wa.

In the same precisely find wa' = moment of *in* with respect to the same plane.

Then $Wx = wa' - wa$ is found.

If moment of *aft out* exceeds numerically the moment of *fore out*, the algebraic sign of wa will be negative; the same holds also for the sign of wa'.

The chief objection to this method lies in the comparative confusion of the ordinates to the different sections on the figure or plan which is used for admeasurement. A little care, however, and experience, would soon overcome this trifling difficulty.

It is evident that the method which is here proposed gives the measures of the quantities whose values are sought with as much accuracy as the nature of an approximation will admit—as far, that is, as Simpson's rule can be depended on—which experience has shown to deviate *very little* from the truth, where proper care is taken not to make the intervals too great.

The calculator would do well to draw in the curve HPP' (Fig. 1) for the locus of the centres of gravity of displacement, which would be a material assistance in giving him an idea of the rolling qualities of the ship, as before observed, and would serve as a basis for approximating to the time of the vessel's oscillation when it has been displaced through a considerable angle.

All this, of course, takes time and trouble; but, when we consider the length of time consumed in the building of each ship, the magnitude of the interests intrusted to its keeping on a most treacherous element, and the loss, not only of valuable property, but of human life, which an error of construction might involve—the few days, or even weeks, which must be spent in calculating *accurately* the various elements, are as nothing in the balance, and should never be admitted as an excuse for neglecting this *most necessary work*.

Renshaw's Composite Cutting Tools.*

Of the long list of machine tools now in existence, the lathe is by far the most ancient, and it is yet the most important—whether we regard it in reference to the extent and variety of its applications, or the intrinsic beauty of its action. But such a tool would be very far from meeting the requirements of the modern engineer, who has, therefore, gradually accumulated separate machines for planing, slotting, shaping, fluting, nut and wheel cutting, and boring machines, with many other specially adapted tools. Each of these is limited in its powers, and is restricted to a particular class of work—so that the engineer is compelled to pass his work through many separate tools before he can complete a single piece of combined mechanism. This system of working is productive of many evils—as the loss of time in transferring and refixing heavy details, and the increase in the chances of error due to repeated readjustments. And in many branches of manufacture, more especially in light work, where good tools would be highly advantageous for occasional use, the expense of the several kinds discourages their adoption. We are, therefore, driven to look for a constructive machine of simple construction which shall in itself unite the functions and powers of the existing detached tools. Professor Willis, in his late Exhibition Lecture at the Society of Arts, has, indeed, generally alluded to this, in speaking of the want of "machines much more comprehensive, and yet simple in form, by means of which the construction of machinery in general will attain to greater perfection, and machine tools be introduced into workshops of a smaller character than at present, in the same manner as the lathe." It is precisely this that Mr. Renshaw has endeavored to carry out in his two chief modifications of, or foundations upon, the common lathe and slotting machine.

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* Condensed from the Practical Mechanic's Journal.

Fig. 1.

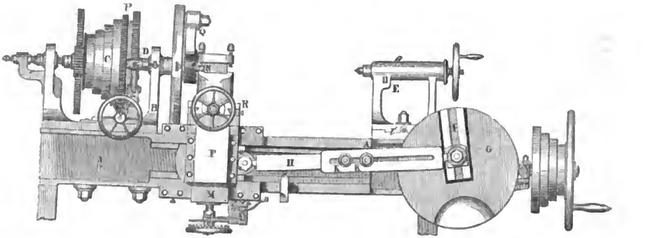
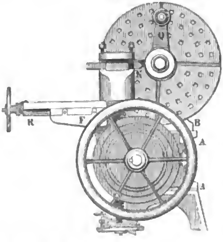


Fig. 1 is a front longitudinal elevation of an ordinary back-geered lathe, to which a portion of the improvements are applied; and Fig. 2

Fig. 2.



is a corresponding end elevation of the lathe, but with the following head-stock removed. In addition to its ordinary functions as a simple turning, boring, and facing lathe, this tool is here changed into a general shaping machine. Of the ordinary portions, A is the bed of the lathe, carrying the fast head-stock B, with its cone speed pulley C, and mandril D; and at the opposite end of the bed is the shifting or following head-stock E. The shaping action is given to the slide-rest F, by the revolution of the crank-disk G—the adjustable connecting rod H of which is jointed at one end by a stud-bolt in the radial slot I, and at the other to the end of a vertical slide-piece, fitted to a dove-tailed recess in the front of the lathe bed, this slide-piece having the slide-rest bolted to it. The length of the rod H is adjustable by means of a long slot and the two stud-bolts K; and the slide-rest, besides its usual movements, has a vertical adjusting slide M. To obtain the necessary rotatory motion for the mandril carrying the work during the action of the cutter N, an endless screw, or worm-spindle O, is set transversely to geer with a worm-wheel P on the mandril. The figures exhibit this compound tool in the act of shaping the boss of a crank Q, whilst it is bolted to the face-chuck on which it was carried during the boring and turning actions—the shaping action being similar to that of the common shaper or slotting machine. As the disk G revolves, the cutting tool N is traversed back and forward, so as to pare off the superfluous metal of the crank-boss, which is set concentrically with the axial line of the mandril, so that the periodical turning of the worm O, by its projecting hand-wheel, carries round the boss as the cutting proceeds. The cutting tool is set in to its work by the top transverse slide R, fitted with a screw and hand-wheel in the usual manner; but, if necessary and convenient, both this horizontal traverse of the cutting tool and the continuous or intermittent rotatory movement of the mandril carrying the work may be made automatic by suitably connecting them with any convenient mover—as at present adopted in planing and shaping machines. When the large boss is pared down, the opposite smaller one may be similarly shaped by reversing the crank upon its face-plate; whilst the rectilinear surfaces of the crank-arm may be planed down by adjusting the surfaces to be reduced so as to agree with the periodical shifting action of the tool by the vertical slide M. Or this right-line shaping may be similarly effected by the horizontal traverse of the tool by means of the slide R, if the tool is shaped to suit—such slide being made automatic when advisable. The figures represent one mode in which the vertical slide M is made self-acting by the traverse movement of the longitudinal slide in working an adjustable incline and a spring, on a tripping lever, with a face-wheel and click.

The details are susceptible of a variety of modifications, among which are proposed the application of a slotted bar to the slide pieces, as an easy means of adjustment, without altering the length of the connecting rod; a mechanical arrangement of a rack and pinion as a substitute for the slotted disk for actuating the cutting slide; a contrivance termed a bed-chuck, for affixing to the lathe-bed, so as to hold objects whilst being planed or slotted, any angle being obtainable by setting the chuck by a graduated index; a slide-rest with clamping screws and curved slots, for setting the tool to any angle, as, for example, in cutting V's; also, change-wheels in connection with the worm O, for cutting articles with numerous sides, as five pitches flutes; or six equally-distant divisions scored on the worm-wheel P, or speed pully C, for clamping by means of the set screw *g*', in planing hexagonal nuts—the planing action being completed while the nut is adjusted on the lathe mandril for facing.

In the various operations of shaping, slotting, planing, fluting, or other species of cutting, either a fixed or a revolving cutter may be used, according to the peculiar nature of the work in hand. At *l*', Fig. 1, the usual arrangement employed for traversing the following head-stock of lathes, in the execution of conical work, is shown, and this mode of adjustment is used, in conjunction with other apparatus, for executing taper polygons, or pyramidal figures held between the lathe centres. Or, otherwise, the fast-head has an angular adjustment on the lathe-bed. Such an arrangement is capable of producing cones, tapered key-ways, conical screws, and other work; and in certain cases, as, for example, in cutting radial grooves in the face of the work, the lathe-head is adjusted at a great angle, or at right angles with the normal centre line, and to the line of traverse of the cutting slide—the slide-rest being thus made capable of motion across the face of the work. In such cases, the lathe-head is partly supported upon a bracket, and this mode may be substituted in any case where it is desirable for the bed-chuck previously mentioned.

It is clear that any, or all, of these several modifications or improvements may be applied to lathes of any description, and to ordinary slotting and shaping machines, as well as to various other constructive tools; thus enabling the machinist of moderate resources to secure most of the advantages hitherto only to be found in extensive workshops, fitted with all the modern examples of perfect, but isolated, tools.

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Incrustations in Boilers.

A COMPOUND of grease, blacklead, and charcoal, for preventing incrustations in steam-boilers, and also for preserving metals and wood, has been produced in Great Britain, and designated after its inventor, as "Sibbald's Metalline Compound." The following is from the specification, enrolled in October last:

Take of tallow or suet, one pound; graphite, or blacklead, finely pulverized, one pound, and charcoal, finely pulverized, one-eighth of a pound. First melt the fat, and then add the other ingredients, which are thoroughly incorporated with it by stirring. To render the mixture more fluid, so that it may be spread more easily over the surfaces to which it is to be applied, oil or gas-tar may with advantage be mixed with it, in the proportion of one gill to the quantities of materials above specified.

In using this compound, it is first warmed, and then applied by means of a brush or other suitable means, to the whole interior of the boiler, which may also be slightly warmed, to facilitate the operation. When applied, it dries almost instantly, and forms a coating resembling in appearance a coat of ordinary black paint. If the boiler be foul, the compound is to be applied directly upon the incrustation; and, after using the boiler for a few days, it will be found that the compound has so thoroughly disintegrated and softened the incrustation, that it can be easily removed from the plates by a scraper or wire brush. When applied to clean boilers, it has the effect of preventing the formation of any hard incrustation, and adheres to the plates with great tenacity and for a considerable length of time.

The compound, in addition to preserving boilers, to which it has been applied, from the injurious effects attendant on the play of the furnace fire over metallic surfaces coated with earthy deposits, appears to increase the evaporating power of even a clean boiler; it has the effect also of stopping leaks at the seams of the boiler-plates, and of preventing the corrosion of the rivets and of the metal at the joints. It is expedient, in most cases, to apply the compound as often as once in two weeks to the most exposed parts of the boiler; but the frequency with which the application should be renewed will depend upon the form of the boiler, the kind of fuel used, and the quality of the water subjected to evaporation.

The peculiarity which distinguishes the improved compound from other substances hitherto applied to steam-boilers, is the property it possesses of adhering to the boiler-plates, notwithstanding the action of the heat, and the abrasion produced by the rapid movement of the sediment and water. This property has been found developed in the highest degree when the combination of the three substances above enumerated have been, substantially, in the proportions stated. When the proportions are materially varied, the property which the compound possesses, of tenaciously adhering to the boiler-plates, will be deteriorated, and the formation of a hard incrustation thereon will not be so effectually prevented.

In addition to this important application, the compound may also be used with great advantage for coating the exterior of boilers, and for defending the bed-plate and frame-work of engines from corrosion, as well as other like metallic surfaces required to be defended from rust or decay.

For ship-building purposes, the compound is also applicable; first, to protect the bolts from corrosion; and, second, to preserve the wood from decay. To protect the bolts, they should be well coated by first covering them with the mixture, and then carefully lining the bolt-holes with it, before inserting the bolts, which can be done by plugging each hole with a piece of the compound, and then forcing through the hole a pointed rod somewhat smaller than the bolt to be driven; and, to insure the effectual coating of the hole, the compound may be rubbed into the wood by the pointed rod. The joints between the timbers may be filled, by pouring into them the compound in a melted state, or caulking it in: this, however, can only be done, with a due regard to economy, when the joints are narrow. The compound should be warmed sufficiently to render it fluid, and then applied by a paint-brush to every part of the surface of the timbers, both before and after they are built into the frame. As the charcoal is a good disinfectant, the coating of the timber in the vessel's hold with it, will be likely to render the air more pure, and the bilge-water less offensive and injurious to health.

Metal roofs for houses, and the frame-work of mills and their machinery, and the iron about docks, piers, and bridges, may be rendered much more durable by a coating of this compound. In short, wood or iron will be protected by it from the injurious action of salt or fresh water, in all situations.

In conclusion, the patentee remarks that it is well known that many fatty substances have properties assimilating to those of suet and tallow, and may be used in place of them; but he is not prepared to state that any others are as good for the purpose. It is also well known that some substances possess, in a greater or less degree, the peculiar absorbent and disinfecting properties of charcoal; and such may be used to replace it, in manufacturing this compound. Of the latter substances, the inventor mentions pulverized coke, but states that, not having had the opportunity of testing it, he cannot recommend its use as a perfect equivalent for charcoal in manufacturing his compound, although it might be supposed to possess the same properties.

The patentee does not confine himself to the precise materials, nor to the proportions above-mentioned; but he claims the right to employ any of the known equivalents of the materials specified above, as well as the materials themselves so specified, and that in any proportions that will produce, substantially, the improved compound above described, and designated as "Sibbald's Metallino Compound." And he claims the application of the improved compound, in the manner and for the purposes above set forth.

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[From the London Artisan.]

Dible's Ventilating Apparatus for Vessels.

THE want of efficient means for ventilating the cabins of steam and sailing vessels is so notorious, that we need not disgust the reader who has ever been sea-sick—and who has not in these travelling days?—by bringing to his recollection that nauseous effluvia from which the unhappy passenger has no escape, except by braving the weather on deck—a source unavailing, except in fine weather and on very short trips. In bad weather, with battened-down hatches, it is still worse, and the restless traveller undergoes all the horrors of the "Black hole of Calcutta;" his sufferings mocked by the gaudy *papier-maché* and crystal ornaments of his prison, luxuries which he would gladly exchange for a taste of the free breath of heaven.

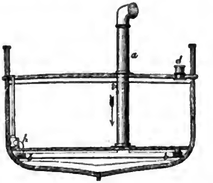
A system of ventilation has been applied to the *Courier* and *Dispatch* steamers, belonging to the Southwestern Steam Packet Company, which has been reported by the manager of the company as entirely successful, and will be also fitted to the whole of that company's vessels. It consists in bringing down pure air from the deck by suitable pipes, which convey it to a space under the cabin floor, whence it is distributed, by means of regulators, throughout the cabins and berths. The heated and impure air is conveyed away from the highest point in the cabins to the deck. With these remarks, the following references will be readily understood.

A large pipe *a* is fixed on deck, with a mouth-piece adapted for catching the wind, on the principle of a wind-sail, and which can be adjusted to any point of the wind. The branch pipes *b b b*, which may be made of wood or metal, distribute the pure air to the cabins through openings in the floor or round the skirting. These openings are provided with revolving gratings, by turning which the quantity of air admitted may be increased or diminished at pleasure. The heated and impure air is carried off through the pipes *d d d*, the tops of which may be protected from spray by being carried up under the seats on deck *e*. An increased exhaustive effect may be obtained in a steamboat by carrying a pipe connecting *d d d* to the chimney. Perhaps the most complete way of effecting this would be to put a casing round the chimney for nearly the whole of its height, into which these pipes could be led, and this casing would also tend to improve the draught in the boiler, by preserving the chimney from being cooled down in its rapid passage through the cold air.

In the *Courier* and *Dispatch* (the cabins of which accommodate 100 to 150 passengers), one pipe forward and one aft, of 15 inches interval diameter, are found amply sufficient to ventilate every part of the vessel. The branch pipes *b b b* are of wood, about four inches by eight inches, but, if more convenient, they could be as readily made round, and in zinc, copper, or iron.

When full open, the current of air through the revolving gratings is found to be very great, even when the vessel is in harbor and stationary, and is quite as much through those at the greatest distance from the main pipe *a* as in the others nearest to it.

The inventor proposes fitting a cock or valve to the ship's side, in communication with the branch pipes *b b b*, so that in case of fire, the cabins, floor, &c., may be flooded with water; and this cock can be opened from the deck by a key or handle.



Or, he says, the cabins can be supplied with *warm air*, by placing the branch pipes in communication with a stove or other suitable apparatus for warming air.

The whole expense of the apparatus is very trifling, as a vessel of 300 or 400 tons could, generally speaking, be fitted for about $200 or $300, and the work can, in most cases, be done by the carpenter of the vessel.

Messrs. Goodridge and Babot, the commanders of the vessels to which this apparatus has been fitted, speak in high terms of its efficiency, and say, "The saloons and cabins of our vessels are now (even when crowded with passengers, and in bad weather, with hatches and skylights down), always fresh, and free from smells, which formerly was not the case. We also find our cabins are drier, from the free circulation of air, than before, and in hot summer weather cooler and more agreeable to the passengers in every respect."

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Ironfounders' Casting Ladles.

The ladle described below has been in use in the London Works, Renfrew, Great Britain, about four years. It was first introduced by the late firm of Henderson Brothers & Co., and continues to be used by Messrs. J. W. Hoby & Co., of these works. We copy from the *Practical Mechanic's Journal:*

The aim of the improvement was to make a ladle which would be simple in itself, easily worked, keep the workmen out of danger, and prevent the spilling of metal, in all of which points the ladle with geering is defective, as, in using it, it is suspended from a crane, and steadied by several workmen at long handles on each side, who have to watch its position, and swing it backwards or forwards to adjust it to the mould, even while the metal is being poured. This is a difficult matter when the quantity of metal is large; and it generally happens that, for want of the means of adjustment, a considerable quantity of the metal is spilt, to the great annoyance of the workmen.

Fig. 1 represents the improved ladle, and the method of working it. It is made of boiler plate; the lower part being hemispherical, and the upper part nearly cylindrical. The gudgeons are formed on a hoop, and are made with square ends, so that long handles may be attached for turning the ladle about and setting it; but these are not necessarily required during the operation of pouring the metal into the mould. The gudgeons are also set so as to be about one inch and a half behind and below the centre of gravity, thus giving the ladle a tendency to fall forward when suspended by the gudgeons; this, however being prevented, while it is being swung to the mould, by a strong folding catch on each side, fixed to the run, and taking hold of the two suspending rods, which are attached to a crosshead in the usual manner. The mouth of the ladle is made broad, and projects about three inches, so as to cover a small hook, formed at the upper end of one of the butt strips, connecting the plates. Fig. 2 represents a support for this hook, temporarily fixed to the side of the moulding box; A being the moulding box; B, eyes fixed to its side for the purpose of holding the support, which is adjusted to the proper height by pins through the perpendicular ends resting on B, and is, besides, steadied laterally by means of wedges. When the ladle is filled with metal, it is suspended from a crane, the hook under the mouth placed on the support, and the side catches thrown back from the suspending rods. The ladle is then raised by the crane, when, from its tendency to fall forward, as already mentioned, the mouth continues to rest on its support, and, consequently, the ladle is gradually tilted up, and the metal poured gently into the mould; the whole operation being performed with much less bustle and confusion, and with more safety and precision, than by the old method. Another great advantage is that of simplicity, as there is no complicated geering or machinery about it, to make, or to get out of order, in use; and therefore it is, perhaps, the cheapest arrangement at present employed for working a large ladle.

Fig. 1.

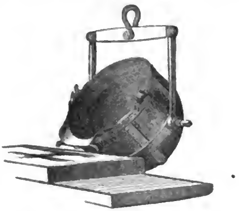
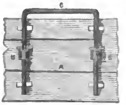


Fig. 2.



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[For Appletons' Mechanics' Magazine.]

General Theory of Elastic Fluid Engines, applied to the Ericsson Engine.

BY J. G. BARNARD, BREVET MAJ. U. S. ENG.

1. Let $a =$ cross section of working cylinder; $m\,a$ do. of supply cylinder.
   $n =$ amount of expansion, *by heat*, in volumes of condensed gas from reservoir.
   $t =$ tension of gas in reservoir: 15 lbs $=$ pressure of atmosphere.
   $l =$ length of stroke.

Then $m\,a\,l =$ capacity of supply-cylinder, and $a\,l =$ do. of working cylinder. Also, $\frac{15}{t}\,m\,a\,l =$ the volume (in reservoir) which is to be expanded n times.

And as $m\,a\,l : \frac{15}{t}\,m\,a\,l :: 1 : \frac{15}{t}$ $\therefore$ the max. resistance of the supply cylinder occurs when the stroke is $1 - \frac{15}{t}$, beyond which the resistance remains constant $= t$.

The volume $\frac{15}{t}\,m\,a\,l$ is expanded n times, and becomes $\frac{15\,a\,l\,m\,n}{t}$

This, in the working cylinder whose cross section is a, is $= \frac{15\,l\,m\,n}{t}$ in altitude.

The stroke l is constant, and may be called $= 1$. Hence the altitude of expanded gas in working cylinder is $\frac{15\,n\,m}{t}$: total height of cylinder being 1.

In order, therefore, that the engine may not work off more gas than it supplies, $\frac{15\,n\,m}{t}$ must be $= 1$, or if less than 1, there must be a cut-off. The use of the cut-off is advantageous in increasing the tension, and it will be introduced into the investigation. t being the tension at moment of cut-off, let t' be the tension at end of stroke (in working cylinder). $\frac{t'}{t}$ will be the portion of stroke up to cut-off, and $1 - \frac{t'}{t}$ the portion in which the gas acts expansively.

2. Let us now find the *mean working pressure* for the stroke. The cut-off being at $\frac{t'}{t}$ part of stroke, the *total quantity of action* (pressure into distance passed over) for the stroke is (see theory of steam-engine)

(A.) $$= \left[a\left(\frac{t'}{t}\right) \times \log.\frac{t}{t'} + a\frac{t'}{t}\right] t.$$ (The clearance of the cylinder is omitted). As the length of the stroke is unity, the above also expresses the mean pressure, in the entire piston, for the stroke. To make use of this expression, it is necessary to find t' in terms of m and n.

Now as the supply must equal the discharge, we can establish a relation. The working cylinder takes from the reservoir, each stroke $a\frac{t'}{t} \div n$ vols. of its condensed gas. The supply furnishes $15\frac{m\,a}{t}$ condensed vols. to the reservoir; hence $a\frac{t'}{n\,t} = 15\frac{a\,m}{v}$,

(B). $$\text{or } \frac{t'}{n} = 15\,m, \text{ or } t' = 15\,m\,n.$$

3. Thus, at whatever point the gas is cut off, its tension at its extreme expansion will be constant so long as m and n are constant. Calling the mean *total* pressure on the piston P, and substituting value of t' in (A), we have

(C). $$P = \left[15\frac{a\,m\,n}{t}, \log.\frac{t}{15\,m\,n} + 15\frac{a\,m\,n}{t}\right] t, \text{ or}$$

$$P = \left[1 + \log.\frac{t}{15\,m\,n}\right] \times 15\,a\,m\,n.$$

As the piston works against the atmosphere, $15\,a$ must be deducted to get the available pressure, which called P' is

(D). $$P' = \left[m\,n + m\,n\log.\frac{t}{15\,m\,n} - 1\right] \times 15\,a.$$

To get the real working pressure of the engine, the resistance of the supply-cylinder must be deducted.

At commencement of stroke, the resistance on supply-piston is 15 lbs.; at $1 - \frac{15}{t}$ of stroke, the resistance becomes equal to t, and remains so; calling the mean resisting pressure p, we have

(E). $$p = \left[a\,m\left(\frac{15}{t}\right)\log.\frac{t}{15} + a\,m\frac{15}{t}\right] t$$

$$= \left(1 + \log.\frac{t}{15}\right) \times 15\,a\,m.$$

4. From (E) must be deducted $15\,a\,m$, the pressure by which the external air opposes the resistance or favors the motion of the supply-piston, and the total resistance (called p') will be

(F). $$p' = 15\,a\,m, \log.\frac{t}{15}$$

The effective mean working pressure of the engine will then be the difference between P' and p' or

(G). $$P' - p' = 15\,a\,m\,n + 15\,a\,m\,n\log.\frac{t}{15\,m\,n} - 15\,a - 15\,a\,m \times \log.\frac{t}{15} = 15\,a\,(m\,n - 1) + 15\,a\,m\Big[(n-1)\log.t - (n-1)\log.15 - n, \log.m\,n.\Big]$$

5. Expression (G) shows, that while m and n are fixed, the working pressure increases indefinitely with t.

On the other hand, when n and t are fixed, the expression will have a maximum in reference to m, which will depend upon the particular values of the first-named quantities. The best value of m will generally be found between ½ and 1, and the pressure may be increased indefinitely by increasing the value of t. t denotes the tension in the reservoir, and its value, or relation to t', (B) will depend on the cut-off. If there is no cut-off, t will be the same as $t' = 15\,m\,n$.

6. If we substitute this value in (G) we have (for the mean working pressure when there is *no cut-off*)

(I). $$P' - p' = 15\,a\,(m\,n - 1 - m\log.m\,n)$$

In which the maximum value corresponds to a value of m, in the neighborhood of unity (when n is equal, or nearly equal, to 2).

But it must be observed, that although the mean working pressure is increased, in these expressions, by increasing m or t, yet it does not follow that these may be increased at pleasure, since, in very narrow limits, their increment makes the resistance of the supply-piston, *towards the end of the stroke*, greater than the pressure on the working piston. Hence the engine could not complete its stroke, unless aided by *another engine*, or by a very heavy fly-wheel.

In the engines of the "Ericsson," the excess would actually exist if a pressure of 12 lbs. was carried in the reservoir, to the extent of 110,000 lbs. at the end of the stroke, hence the two engines, or four cylinders, would act rather as one than two engines.

7. In single engines, it would not be admissible to allow any excess to exist, since, even with a heavy fly, the velocity would be very unequal.

To determine t and m, so that the resistance to the supply shall be *just equal* to the force of the working piston *at end of stroke*, make

$$(t' - 15)\,a = (t - 15)\,a\,m.$$

(t' being the final pressure in the working cylinder, and t [the tension of the reservoir] being that of the supply cylinder),

$$\text{or, } t = \frac{t' + 15\,(m-1)}{m}, \text{ but } t' = 15\,m\,n, \qquad \text{(B).}$$

hence $$t = \frac{15\,m\,n + 15\,(m-1)}{m} = 15\,(n+1) - \frac{15}{m}$$

Substituting this in the expression for $P' - p'$

(K). $$P' - p' = 15\,a\,(m\,n - 1) + 15\,a\,m\left[(n-1)\log.\left(15\,(n+1) - \frac{15}{m}\right) - (n-1)\log.15 - n\log.m\,n.\right]$$

8. The foregoing expression is zero when m is ½ (n being 2); is a maximum when m becomes nearly equal to unity; then decreases and becomes zero again when m is about 1½. The regulation of pressure attained in this formula (so that the resistance shall not exceed the final pressure) is effected by the cut-off.

We must therefore examine the expression for the point of cut-off, to see how far it is practicable.

The portion of stroke up to cut-off is represented by $\frac{t'}{t}$, or in this case by $\dfrac{15\,m\,n}{15\,(n+1)-\dfrac{15}{m}}$ or $\dfrac{m\,n}{n+1-\dfrac{1}{m}}$

This must always be less than unity, hence the equation

$$m\,n = n + 1 - \frac{1}{m}$$

will give the extreme value m may have, consistent with the cut-off being used to produce the intended effect. This gives two values

$$m = 1, \text{ or } m = \frac{1}{n}$$

These are the extreme values of m under the supposition of paragraph 7; though freed from that condition (that the resistance of the supply shall not exceed the final pressure of the working cylinder), a pair of engines might be worked with the supply but ½ the working cylinder, by use of the cut-off.

The above shows, that for a single engine, worked in such a way that the resistance of the supply shall not exceed the final pressure of working cylinder, the maximum of effect will be attained by making m nearly equal to 1,* or the supply nearly equal to the working cylinder. But it must be observed, that though it never *exceeds*, yet the resistance of the supply becomes, with this value of m, *equal* to the pressure of the working cylinder, at a little beyond one-half the stroke; there is, therefore, no working power for one-half the stroke, and the piston would only move (in a single engine) by momentum derived from a heavy fly-wheel. This would produce a great inequality of motion, and would be almost inadmissible; but we will use this limit to obtain the extreme working pressure which can be obtained for a single air-engine.

9. Take one of the engines of the Ericsson as an example, making the supply equal to the working cylinder: $a = 22{,}100$ sq. inches, $m = 1$, $n = 2$, and we have the mean working pressure for the stroke.

$$P' - p' = 15 \text{ lbs.} \times 22{,}100 + 15 \text{ lbs.} \times 22{,}100\ (\log.\ 2 - 2\log.\ 2)$$
$$= 101{,}770 \text{ lbs.}$$

mean working pressure for stroke.

This pressure, with 6 feet stroke, and 10 revolutions per minute, would give $\dfrac{101{,}770 \times 12 \times 10}{33{,}000} = 370$ aggregate horse-power. But the number of strokes will, in practice, depend upon the rate at which air can be expanded. This is the *maximum power* which can be given to a single engine (one pair of working cylinders) of the size of those of the Ericsson; and it is doubtful whether this is attainable from the entire want of working pressure during one-half the stroke, referred to above.

But by uniting four cylinders into one engine, as is done on the "Ericsson," there is afforded an opportunity to gain power by use of high tension, as each piston may terminate its stroke against a considerable resistance, by help of its mates. This must be actually done on the Ericsson if a tension of above seven or eight pounds is used.

10. Let us calculate by formula (G) the power of one of the "Ericsson" engines, as actually worked:

Put $a = 22{,}100$, $m = \dfrac{2}{3}$, $n = 2$, and $t' = 15\,m\,n = 20$ lbs., $\dfrac{t'}{t}$ (cut-off) $= \frac{2}{3}$, hence $t = 30$ lbs. (tension of reservoir), or 15 lbs. above atmosphere,

$$P' - p' = 15 \times 22{,}100 \left(\frac{4}{3} - 1\right) + 15 \times 22{,}100 \times \frac{2}{3}\left(\log.\ 2 - 2\log.\ \frac{4}{3}\right)\dagger = 110{,}500 + 221{,}000\ [0{\cdot}11765] = 136{,}500 \text{ lbs.}$$

mean working pressure for stroke,

$$\text{or } \frac{136{,}500 \times 12 \times 10}{33{,}000} = 490 \text{ aggregate horse-power.}$$

The above supposes the air doubled, but this is not done on the "Ericsson," since the temperature is stated at but 380° above atmosphere: which would give an expansion of but $1\frac{1}{5}$. To double fully the air requires a temperature over 600°, and probably beyond practicable limits. To calculate on this expansion we have, $n = 1\frac{1}{5}$, $t' = 18$ lbs., and $t = \frac{3}{2}\,t'$, $= 27$ lbs.

$$P' - p' = 15 \times 22{,}100 \left(\frac{6}{5} - 1\right) + 15 \times 22{,}100 \times \frac{2}{3}\left[\frac{4}{5}\ \log.\ \frac{27}{15} - 1\frac{4}{5}\ \log.\ \frac{6}{5}\right] = 66{,}300 + 221{,}000\ [0{\cdot}142] =$$
$$97{,}682 \text{ lbs.,}$$

which, at ten revolutions per minute, would give rather over 350 aggregate horse-power (one engine).

11. To determine those values of m and t, in formula (G), which will be the most favorable, is a matter which depends rather on considerations connected with the manner of working the engines and heating the air, than upon mathematical calculations, since it has been shown, that for a given value of m, the mean working pressure increased indefinitely with t. The best value of m is somewhere between ½ and 1, and in the "Ericsson" engines it is ⅔.

Although the formula indicates that the working pressure increases indefinitely with t (tension of reservoir), yet, in practice, the degree of increment which may be obtained in this way, is confined to narrow limits, which will be best understood by reference to the relation which exists between t and t'. t' is the tension of air which would exist in the reservoir and working cylinders when no cut-off is used, and is *always* the tension of air in working cylinder *at the end of the stroke*. t is the increased tension of the air in the reservoir, and in the working cylinder (before the air is cut off) caused by the use of the cut-off.

Shortening the cut-off increases t indefinitely.

12. The considerations which limit the value of t are:

1st. When much greater than t', a great excess of resistance over working pressure ensues, towards the end of the stroke; a state of things inadmissible in a single engine, and only admissible within narrow limits when two engines are coupled.

2d. The degree of pressure to which it would be safe to expose the large, heated cast-iron cylinders, would not probably exceed 15 or 20 lbs. (above atmosphere).

3d. The heating apparatus requires a certain time to heat the column of air which passes through and over it, and this time cannot probably be much less than the whole duration of the stroke; the use of the cut-off limits the time to that portion of the stroke before the cut-off takes place.

13. The first consideration will alone possess a controlling influence over the increase of t. If the engines of the "Ericsson" should work at a tension of 12 lbs. above atmosphere in the reservoir (as it is stated they are to do), it can be shown that the *excess* of resistance on one piston, at the end of its stroke, is greater than the entire working pressure on the cylinder of the mate engine.*

If we apply formula (X) to determine the power of one of those engines, with cut-off so arranged as to produce no such excess of resistance, we should have (making $a = 22{,}100$) $m = \frac{5}{6}$ and $n = 1\frac{1}{5}$

$$P' - p' = 15 \times 22{,}100 \times \tfrac{1}{5} + 15 \times 22{,}100 \times \tfrac{2}{3}\ [-0{\cdot}120]$$
$$= 66{,}300 - 26{,}520 = 39{,}780 \text{ lbs. mean working pressure.}$$

which would give each engine less than 150 horse-power.

14. If our formulas are correct, it would appear that larger supply-cylinders than the "Ericsson" has, would have been advantageous; since (par. 9), with supply equal to the working cylinder, a much higher power was obtained without incurring an excess of resistance; and even higher (par. 10) than the actual engines of the "Ericsson," with a ⅔ cut-off.

But the larger the supply-cylinder, the greater the quantity of air which has to be heated each stroke, and this may limit its increase.

15. In order to form some definite idea of the degree to which the working power may be increased, by increasing m and t, it is neces-

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* I find $m = 0{\cdot}95$, about the maximum; but the increase is slow beyond $m = 0{\cdot}8$.

† It must be borne in mind that in mathematical formulas, Naperian logarithms are always used.

* The connections of the two engines, and their relative positions with respect to the position of the crank, would give one piston a powerful leverage in carrying the other through its intervals of negative pressure, but the necessity of this mutual aid is objectionable.—[*Ed. App. Mech. Mag.*]

sary to fix some limit to the degree to which the resistance of the supply-cylinder, at end of stroke, may be permitted to exceed the working-pressure. With a ⅔ cut-off this resistance will, in the "Ericsson" engines (if worked with a pressure anywhere approaching 12 lbs.) be equal to, and even exceed, by a large amount the total working pressure of the two working pistons in action. This seems inadmissible. If we establish the rule that this resistance on our supply-piston at the end of its stroke shall not exceed ½ of the available working pressure on the piston of the mate engine, we shall have the equation (for all cases in which t is less than 30 lbs.):

$$a\,m\,(t-15) - a\,(t'-15) = \tfrac{1}{2}\,[a\,(t-15) - a\,m\,(t-15)]$$

substituting the value of $t' = 15\,m\,n$, the value of t will be found

$$(\text{L}).\qquad t = \frac{30\,m\,n - 45\,(1-m)}{3\,m-1}$$

which gives the extreme value that t can have under this supposition.

If we apply this to the "Ericsson's" engines, we have, $m = \frac{2}{3}$, $n = 1\frac{4}{5}$, $t = 21$, $t' = 18$, and $\frac{t'}{t}$, or the cut-off, $= \frac{6}{7}$, whereas it is stated to be ⅔, or 0·63.*

16. In order to exhibit to the eye the power, as determined by the formula, which atmospheric engines may exert, I subjoin the following computations:

Ericsson's engines; area of working cylinder = 22,100 square inches; $m = \frac{2}{3}$, n, or the expansion, being supposed $1\frac{4}{5}$, and cut-off, $\frac{2}{3}$; $t = 27$, or 12 lbs. above atmosphere, and $t' = 18$; mean working pressure, 97,682 lbs.

Same engine, worked so that the resistance of supply-cylinder shall be regulated by formula (L); t equal to 21, 6 lbs. above atmosphere; $t' = 18$, and cut-off, $\frac{t'}{t}, = \frac{6}{7}$. These values in formula (G) give the mean working pressure, = 53,261 lbs.

Same engines, worked so that the resistance of the supply-cylinder shall at no time exceed the pressure on *its own* working piston (vide par. 13); mean working pressure = 39,780 lbs.; $t = 19\frac{1}{2}$ lbs., $4\frac{1}{2}$ lbs. above atmosphere; and cut-off at over $\frac{9}{10}$ths.

The horse-power in these three cases, supposing 10 revolutions per stroke, would be equal to 350, 195, and 150 horse-power.

If we suppose the air to be actually doubled, we should have, instead of the foregoing, the following mean working pressures, viz.: 136,500 lbs., 96,356 lbs., and 72,930 lbs.; the value t (tension of reservoir) being 30, 25, and $22\frac{1}{2}$ lbs.; and the horse-powers, at 10 revolutions = 490, 350, and 270 horse-power.

The highest admissible manner of working the engines is the second, in which the tension is limited by formula (L), which gives 195 and 350 horse-power, according as the air may be expanded $1\frac{4}{5}$, or double.

18. If the supply cylinder, or m, were $\frac{8}{10}$ instead of $\frac{2}{3}$, we should have, on the same limitations of formula (L), 62,000 and 114,000 lbs. mean pressure, according as the expansion is taken at $1\frac{4}{5}$ or 2; corresponding to 225 and 415 horse-power.

It would appear from these calculations, as observed before, that supply-cylinders larger than ⅔ would work more advantageously.

19. The air cannot be expanded by the temperatures stated to be employed in the "Ericsson's" cylinders, more than $1\frac{4}{5}$; and it is probable that actual doubling is impracticable, as it requires a temperature of 600°; the red heat of iron in the dark.

With this expansion, they cannot work over 200 horse-power each, nor, if doubled, over 350. By using a supply-cylinder of $\frac{8}{10}$, it would appear that these figures might be increased to 225 and 415 horse-power.

20. These figures are the theoretical maximii of *aggregate* horse-power, assuming 10 revolutions per minute as a standard of comparison. But the actual number of revolutions will depend on the rate at which the air may be heated by the apparatus. From these maximum aggregates there are many deductions to be made.

1st. The air has been assumed of equal tension in supply-cylinder, after it commences acting in the reservoir and in the working cylinder; but it is evident some force is required to pass the air through the regenerators.

2d. The fluctuation of tension in the reservoir, arising from the fact that the supply is not perfectly simultaneous with the draft. In single engines this would be serious and can be estimated,* but when double engines are used, having a common reservoir, this fluctuation is much reduced, because one or the other of the supply cylinders is always acting, though it is still sensible, particularly when a cut-off is used.

3d. Leakage.

4th. Friction and working of valves.

The 1st and 3d items cannot be estimated, though their effect would be sensibly felt.†

21. The 2d item can be easily calculated in case of a single engine, but its effect is comparatively small, and the calculation complicated in case of double engines having a common reservoir.

22. The amount to be allowed for friction, working of valves, &c., can only be known by experience.

Mr. Ericsson states, I believe, that ½ lb. pressure on his working piston is sufficient to overcome friction. This is very small, compared to what is usually allowed for steam-engines, when the 4 enormous pistons which each engine carries, are considered; but if taken as correct, it would take off from 12 to 20 per cent. from the horse-power of the engines, according as they may be estimated at 200 or 350 horse-power.

23. The 1st and 3d items will also cause a sensible deduction, and in addition to this, there is another that operates seriously against the working power of the engine, viz., the development of heat in the reservoir by the compression of the air, as it comes from the supply-cylinder. Air at 60°, compressed to a tension of 25 lbs., would have its temperature raised to 120° or 130°. Having this temperature as it enters the regenerators, it receives so much less expansion by the heating apparatus, or requires so much higher temperature to give the intended expansion. This constitutes another reason why the air cannot be actually doubled, in practice.

A slight reduction in the ratio of expansion, has a powerful effect in reducing the working power of the engines, since the formula gave, under the same circumstances, but with an expansion of but $1\frac{4}{5}$th, 195 instead of 350 horse-power.

With so many uncertain or undetermined elements operating, it is not possible to use figures with precision, but it is pretty safe to say that the actual working power of each engine of the "Ericsson" cannot exceed 250, and more likely is as low as 150 horse-power.‡

When the enormous dimensions of these engines are considered, and their very limited power, scarcely that of a single 60-inch steam-engine, very sanguine hopes cannot be entertained that the principle

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* The cut-off is adjustable, we cannot give the usual point adopted. The quantity 0·63 was published in the "Notes," on page 30, as an approximation to the point at which it was working on the second trial trip.—[*Ed. App. Mech. Mag.*]

* In case of a single engine, the loss of tension may be estimated as follows: let r represent the ratio of the cubic contents of the reservoir, to those of the working cylinder, considered as the unit of volume and the length of stroke, unity; t the tension of air in reservoir at commencement of the stroke; t'' the diminished tension, caused by the draft upon the reservoir before the supply-cylinder begins to act; $1 - \frac{15}{t''}$, will be the portion of stroke performed at the moment its action commences, and $\frac{t''-15}{n\,t''}$, the fractional volume of condensed air drawn from the reservoir by the working cylinder. The tensions t and t'' of reservoir, at the commencement and at this period of stroke, will be in the following proportion: $t : t'' :: r : r - \frac{t''-15}{n\,t''}$; reducing this to an equation, the value of t'' will be found.

$$t'' = \tfrac{1}{2}\,\frac{n\,r-1}{n\,r}\,t \pm \sqrt{\frac{1}{4}\left(\frac{n\,r-1}{n\,r}\right)^2 t^2 + \frac{15}{n\,r}\,t}.$$

To apply this, put $t = 25$ lbs., $n = 2$, $r = 4$; figures which correspond to the 2d (350 horse-power) estimate of the "Ericsson" engines (par. 17), with a reservoir 4 times the capacity of the working cylinder; and t'' is found equal to 23·8425 lbs., showing a running down of working pressure of 1·1575 lbs.

† The engine log of the Steamer "Arctic" shows a uniform difference of 2 lbs. between the tension of the steam in the cylinders and in the boilers.

The power required to force the air through the regenerators and valves of the air-engine would seem to be greater than that to force steam through the valves of a steam-engine.

‡ The formula, however, give higher figures than these, if larger supply-cylinders are used, but the practicability of doing this, I am unable to judge of, as it depends upon the power of the heating apparatus to expand the increased quantity of air

can ever be applied to ocean navigation; and barely any at all, so long as the peculiarities of their manner of working require that they shall be single acting.

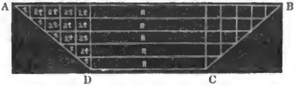
[For Appletons' Mechanics' Magazine.]

Excavation and Embankment.

BY WILLIAM ROCK, CIVIL ENGINEER, COVINGTON, KY.

No. I.

To calculate a table of cubic yards, corresponding to mean cuttings, expressed in feet and tenths of a foot:



Let the diagram A B C D represent a cross-section in excavation or embankment—the horizontal lines being at the distance of one-tenth of a foot apart, and the vertical lines on each side of the roadway, or width of grade D C, being at a distance apart equal to one-tenth of a foot, multiplied by the ratio of the side-slope to unity.

In the diagram, R R may represent the area due to the width of grade, multiplied by one-tenth of a foot; or it may represent a rectangular prism, having the above area for a base, and having for its altitude the length of a station, or the distance between two consecutive cross-sections: *t* may represent a triangular area, having one-tenth of a foot altitude, and a base equal to one-tenth of a foot, multiplied by the ratio of side-slope to unity; or it may represent a triangular prism, having an altitude equal to the distance between two consecutive cross-sections, and having for a base the area just described.

In the following investigation, those letters will be taken as representing solids, expressed in cubic yards; the length of station will be taken at 100 feet; and *s* will be taken to represent the ratio of the side-slope to unity, or the base corresponding to a unit of altitude.

By inspecting the diagram, it is evident that

The first $\frac{1}{10}$ foot of cutting gives $R + 2t$.
The first $\frac{2}{10}$ " " gives $2R + 8t$.
The first $\frac{3}{10}$ " " gives $3R + 18t$.
The first $\frac{4}{10}$ " " gives $4R + 32t$.
The first $\frac{5}{10}$ " " gives $5R + 50t$.

Arrange the quantities thus obtained in the following manner:

$$R + 2t,\ 2R + 8t,\ 3R + 18t,\ 4R + 32t,\ 5R + 50t,\ 6R + 72t,\ \&c.$$

By taking the first from the second, the second from the third, the third from the fourth, &c., we have the first order of differences, as follows:

$$R + 6t,\quad R + 10t,\quad R + 14t,\quad R + 18t,\quad R + 22t,\ \&c.$$

Thus we see that the solidities corresponding to consecutive cuttings do not increase in arithmetical proportion. In order to discover the exact law of formation, let us take the first remainder from the second, the second from the third, the third from the fourth, &c.; we thus obtain the second order of differences, as follows:

$$4t,\quad 4t,\quad 4t,\quad 4t,\quad 4t,\ \&c.$$

Hence it appears that the cubic yards corresponding to consecutive cuttings increase by the addition of an increasing arithmetical series, whose common difference is equal to $4t$. Therefore it is only necessary, in calculating a table of cubic yards, to calculate directly the cubic yards for any two cuttings differing from each other by one-tenth of a foot, and to take the difference in the number of cubic yards thus computed. Then add to the difference thus obtained $4t$, and this sum added to the greater quantity of cubic yards, computed directly, will give the number of cubic yards corresponding to the next greater cutting.

To illustrate the process further, let *a*, *b*, *c*, *d*, *e*, &c., represent the cubic yards due to given cuttings, varying in depth one-tenth of a foot. Then, as above demonstrated:

$$b - a + 4t = c,\qquad c - b + 4t = d,\qquad d - c + 4t = e,\ \&c.$$

By resuming the quantities represented in the diagram, and arranging them in the following manner, the best method of making the computations will at once become evident:

Cuttings.	Variable.	Cubic Yards.
$\frac{1}{10}$		$R + 2t$.
$\frac{2}{10}$	$R + 6t$.	$2R + 8t$.
$\frac{3}{10}$	$R + 10t$.	$3R + 18t$.
$\frac{4}{10}$	$R + 14t$.	$4R + 32t$.
$\frac{5}{10}$	$R + 18t$.	$5R + 50t$.
$\frac{6}{10}$	$R + 22t$.	$6R + 72t$.
$\frac{7}{10}$	$R + 26t$.	$7R + 98t$.
$\frac{8}{10}$	$R + 30t$.	$8R + 128t$.
$\frac{9}{10}$	$R + 34t$.	$9R + 162t$.
1	$R + 38t$.	$10R + 200t$.

Thus the manner of forming the table is evident. The variables increase by $4t$; and the variable opposite any cutting, added to the cubic yards opposite the next less cutting, gives the cubic yards opposite to the next greater cutting.

The next step in the investigation is to find the numerical value of *t*, and R in cubic yards.

The altitude of *t* is $\frac{1}{10}$ foot.

$$\text{Base} = \frac{1}{10} \times S = \frac{S}{10}\ \text{foot.}$$

$$\text{Area of } t = \frac{S}{10} \times \frac{1}{10} \div 2 = \frac{S}{200}\ \text{square feet.}$$

$$\text{Cubic yards in prism } t = \frac{S}{200} \times 100 \div 27 = \frac{S}{54}.$$

$$\text{When } S = 1\tfrac{1}{2} \text{ to } 1, \text{ then } \frac{S}{54} = \frac{1\frac{1}{2}}{54}, \text{ and } 4t = \frac{4S}{54} = \frac{6}{54}.$$

$$\text{" } S = 1 \text{ to } 1, \text{ then } \frac{S}{54} = \frac{1}{54}, \text{ and } 4t = \frac{4S}{54} = \frac{4}{54}.$$

$$\text{" } S = \tfrac{1}{2} \text{ to } 1, \text{ then } \frac{S}{54} = \frac{\frac{1}{2}}{54}, \text{ and } 4t = \frac{4S}{54} = \frac{2}{54}.$$

$$\text{" } S = \tfrac{1}{4} \text{ to } 1, \text{ then } \frac{S}{54} = \frac{\frac{1}{4}}{54}, \text{ and } 4t = \frac{4S}{54} = \frac{1}{54}.$$

To determine R, let w = width of roadway, then cubic yards in

$$R = w \times \frac{1}{10} \times 100 \div 27 = \frac{10w}{27}.$$

$$\text{When } w = 18 \text{ feet, then } R = \frac{10w}{27} = \frac{180}{27} = 6\frac{18}{27} \text{ cubic yards.}$$

$$\text{" } w = 20 \text{ " " } R = \frac{10w}{27} = \frac{200}{27} = 7\frac{11}{27} \text{ "}$$

$$\text{" } w = 24 \text{ " " } R = \frac{10w}{27} = \frac{240}{27} = 8\frac{24}{27} \text{ "}$$

Hence it appears that we have for $\frac{1}{10}$ foot cutting, when the width of roadway is 18 feet, and slope = $1\frac{1}{2}$ to 1,

$$R + 2t = 6\frac{18}{27} + \frac{3}{54} = 6\frac{39}{54} \text{ cubic yards.}$$

$$\tfrac{2}{10} \text{ foot cutting} = 2R + 8t = 13\frac{9}{27} + \frac{12}{54} = 13\frac{30}{54} \text{ "}$$

$$\text{Difference} = R + 6t = 6\frac{18}{27} + \frac{9}{54} = 6\frac{45}{54} \text{ "}$$

Now arrange the quantities thus computed, as shown in the above table, and the cubic yards may be got out by simple addition to any extent, and with perfect accuracy:

Cutting.	Variable.	Cubic Yards.	Cutting.	Variable.	Cubic Yards.
$\frac{1}{10}$	$+\frac{6}{54}$	$6\frac{39}{54}$	$\frac{8}{10}$	$7\frac{27}{54}$	$56\frac{48}{54}$
$\frac{2}{10}$	$6\frac{45}{54}$	$13\frac{30}{54}$	$\frac{9}{10}$	$7\frac{33}{54}$	$64\frac{27}{54}$
$\frac{3}{10}$	$6\frac{51}{54}$	$20\frac{27}{54}$	1·0	$7\frac{39}{54}$	$72\frac{12}{54}$
$\frac{4}{10}$	$7\frac{3}{54}$	$27\frac{30}{54}$	1·1	$7\frac{45}{54}$	$80\frac{3}{54}$
$\frac{5}{10}$	$7\frac{9}{54}$	$34\frac{39}{54}$	1·2	$7\frac{51}{54}$	88
$\frac{6}{10}$	$7\frac{15}{54}$	42	1·3	$8\frac{3}{54}$	$96\frac{3}{54}$
$\frac{7}{10}$	$7\frac{21}{54}$	$49\frac{21}{54}$			

This table is for a slope of $1\frac{1}{2}$ to 1, and a width of roadway equal to 18 feet. But from the illustrations above given, it is evident that tables for any other slope and width of grade may be computed with equal facility.

It is also evident that the calculations may be commenced at any cutting whatever, and be continued by the series.

Thus, let it be required to commence the above table at 20 feet cutting, and to extend it at pleasure, calculate directly the cubic yards for 20 feet and for $20\frac{1}{10}$ feet cutting.

For 20 feet cutting, we have, . . . $3555\frac{30}{54}$ cubic yards.
For $20\frac{1}{10}$ " " . . . . $3584\frac{27}{54}$ "
Difference, ... $28\frac{51}{54}$ "

Now, by the series, we have—

20·	$+\frac{6}{54}$	$3555\frac{30}{54}$
20·1	$28\frac{51}{54}$	$3584\frac{27}{54}$
20·2	$29\frac{3}{54}$	$3613\frac{30}{54}$
20·3	$29\frac{9}{54}$	$3642\frac{39}{54}$
20·4	$29\frac{15}{54}$	3672
20·5	$29\frac{21}{54}$	$3701\frac{21}{54}$
20·6	$29\frac{27}{54}$	$3730\frac{48}{54}$
&c.	&c.	&c.

After having computed a table of cubic yards, the most convenient method of arranging the quantities for practice, is to rule a table, and place the cutting, in feet, in the left vertical column, and the cutting, in tenths, in the upper horizontal column; the cubic yards are then placed opposite the feet, and under the tenths, as follows:

	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0	0	7	14	21	28	35	42	49	57	65
1	72	80	88	96	104	113	122	129	138	146
2	156									
3										
4										
5										

The method of taking out the cubic yards from the tables by the prismoidal formula is tedious, and as the method of taking out the quantity corresponding to the arithmetical mean of the end cuttings is known to be erroneous, it is necessary to have a correction calculated and arranged in a convenient form on the same page with the table of mean cuttings. The investigation of a formula for calculating those corrections, answering to any slope and width of groove, will form the matter for a second communication.

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Deep-Sea Soundings.

The following extracts from a letter received from Captain H. M. Denham, dated H. M. S. *Herald*, 29th of November, 1852, Table Bay, Cape of Good Hope, give the results of some interesting experiments on the depth and temperature of the sea in the South Atlantic Ocean. The position, it will be seen, is in about the parallel of the mouth of the river Plata, and about half way between the American continent and Tristan d'Acunha. We have recorded similar experiments of Captain Sir James Ross, Sir Edward Belcher, and Capt. E. Barnett, and others. This, however, is far beyond any of theirs.

Sir James Ross, 2426, 27° 4′ S., 17° 5′ W.; 2677, 33° 3′ S., 9° 1′ E.;

Sir E. Belcher, 3065, 0° 4′ N., 10° 6′ W.; 1620, 4° 2′ S., 9° 6′ W.;

Captain Barnett, 41° 2′ N., 44° 3′ W., 3700 attempted, broke for want of more, by effects of current.

Lieut. Gouldsborough, U. S. N., 3100, 28° 3′ S., 29° 3′ W.; p. 433, Commander J. Adams, from a New York paper, but unauthenticated by any other document we have seen, deepest being 5500 fathoms, in 32° 1′ N., 44° 8′ W.

H. M. S. *Herald*, as follows (7706 fathoms), obtained in lat. 36° 49′ S., 37° 6′ W., on her exploring voyage to the South Seas, under the command of Captain H. M. Denham, F. R. S., 30th October, 1852.

The following is the extract of the letter referred to:

"We reached the lat. of 36° 49′ S., and long. 37° 6′ W., on the 30th of October, when the fineness of the weather permitted me to employ the 15,000 fathoms of sounding line which Commodore McKeever, of the United States Navy, had very generously presented to me, and we had the gratification of obtaining the (I believe) unprecedented sounding of 7706 fathoms, equal to 8¾ English miles, the particulars of which I have tabulated as inclosed.

"Such was the apparent increase of the magnetic variation as we proceeded eastward, on the parallel of 37° S., that the effecting a landing on Tristan d'Acunha to test the actual amount, free from any local disturbances of the ship, appeared to me an essential step. Availing myself, therefore, of the tranquil state of the weather, on the day of sighting it (12th November), I effected a landing on the island, with the necessary instruments for settling the longitude, as well as the variation of the compass, and the shore data at once confirmed what had been indicated afloat, viz., that the variation has doubled in amount since 1813, being now in that vicinity 20° 4′ W., instead of 9° 51′ W.

A TABLE showing the Rate at which the 9 lb. Plummet (11·5 by 1·7 inches) descended with a Line of 1-10th of an inch diameter (and weighing, when dry, 1 lb. per 100 fathoms) through a depth of nearly 9 English miles of Ocean Water, at which depth it apparently reached the bottom.

Successive Depths.	Notation.			Interval per 100 Fathoms.			Interval per 1000 Fathoms.			Successive Depths.	Notation.			Interval per 100 Fathoms.			Interval per 1000 Fathoms.		
	h.	m.	s.	h.	m.	s.	h.	m.	s.		h.	m.	s.	h.	m.	s.	h.	m.	s.
Immersion	8	30	45							4100 Fathoms.	11	49	10		9	41			
100 Fathoms.		32	15		1	30				4200 "		57	45		8	35			
200 "		34	20		2	5				4300 "	12	6	10		8	25			
300 "		36	45		2	25				4400 "		14	45		8	35			
400 "		39	15		2	30				4500 "		21	40		7	55			
500 "		42	4		2	49				4600 "		31	5		9	25			
600 "		45	0		2	56				4700 "		40	10		9	5			
700 "		48	0		3	0				4800 "		48	35		8	25			
800 "		51	5		3	5				4900 "		57	10		8	35			
900 "		54	20		3	15				5000 "	1	6	35		9	25	1	27	6
1000 "		58	0		3	40	0	27	15	5100 "		17	55		11	20			
1100 "	9	1	50		3	50				5200 "		27	0		9	5			
1200 "		5	45		3	55				5300 "		36	25		9	25			
1300 "		9	30		3	45				5400 "		45	55		9	30			
1400 "		12	45		3	15				5500 "		56	15		10	20			
1500 "		16	40		3	55				5600 "	2	6	55		10	10			
1600 "		20	40		4	0				5700 "		19	40		12	45			
1700 "		24	50		4	10				5800 "		30	15		10	35			
1800 "		29	0		4	10				5900 "		40	55		10	40			
1900 "		33	15		4	15				6000 "		52	0		11	5	1	45	25
2000 "		37	40		4	25	0	39	40	6100 "	3	5	10		13	10			
2100 "		42	0		4	20				6200 "		14	40		9	30			
2200 "		46	30		4	30				6300 "		25	20		10	40			
2300 "		51	0		4	30				6400 "		37	55		12	35			
2400 "		55	30		4	30				6500 "		48	0		10	5			
2500 "	10	0	5		4	35				6600 "		57	50		9	50			
2600 "		4	45		4	40				6700 "	4	8	0		10	10			
2700 "		9	45		5	0				6800 "		19	15		11	15			
2800 "		14	50		5	5				6900 "		30	45		11	30			
2900 "		20	10		5	20				7000 "		41	15		10	30	1	49	15
3000 "		25	50		5	40	0	48	10	7100 "		52	15		11	0			
3100 "		30	15		4	25				7200 "	5	1	50		9	35			
3200 "		36	15		6	0				7300 "		11	40		9	50			
3300 "		43	10		6	55				7400 "		24	10		12	30			
3400 "		50	40		7	30				7500 "		34	20		10	10			
3500 "		58	45		8	5				7600 "		44	22		10	2			
3600 "	11	6	50		8	5				7706 "		55	30		11	8	1	14	15
3700 "		14	45		7	45				Total Fathoms 7706 = 15-412 yards = 8¾ English miles.						Total Interval.	9	24	45
3800 "		22	30		7	45													
3900 "		31	10		8	40													
4000 "		39	29		8	19	1	13	39										

NOTE.—This line could sustain 78 lbs. in air, at a suspension of one fathom; but as the 7706 fathoms weighed 77 lbs. (in addition to the plummet) became weighed one-half more by saturation, (equal to 115 lbs.) it could not bring up the plummet again to exhibit to us the nature of the bottom; it broke whilst carefully reeling it in, at 140 fathoms below the water line.
H. M. DENHAM, Captain, R. N.

"I took the opportunity of another calm day to ascertain the temperature of the sea at 900 and at 1000 fathoms. At both depths it proved the same, viz., 40° of Fahrenheit, whilst near the surface it was 58°. At the same time I employed means for tracing the depth to which the sun's rays penetrated, and found it to be 66 feet."

As we considered the foregoing statement would have been imperfect unless accompanied by particulars of this interesting proceeding, contained in Captain Denham's letter to the Hydrographer, Sir Francis Beaufort, it is with much satisfaction that, with his permission, we are enabled to add to it the following extract:

"I must not omit, even in this, to allude to the generous offering to our expedition of 15,000 fathoms of sounding line by Commodore McKeever, of the United States Navy, whose broad pendant was flying on board the *Congress* frigate at Rio. He was not content with presenting me with books, &c., but having observed that he had something *in our way*, sent me, the day before he sailed, 10,000 fathoms on one reel, and 5,000 fathoms on another, of most admirably adapted line for experimenting in deep deep-sea casts. Without compunction as to ships' stores, I determined to hazard the 10,000 fathoms (beautifully laid up, or grafted into one length) the very first opportunity; and we as assuredly did get to the bottom at 7706 fathoms, as not actually bringing up a sample can permit me to say, for I and Lieut. Hutchison, in separate boats, with our own hands, drew the plummet up 50 fathoms several times, and after it had renewed its descent with the same velocity it had done during the last hundred fathoms, it landed on each occasion abruptly to the original mark to a fathom, and would not take a turn more off the reel. By its parting at 140 fathoms from the surface, we lost a six's thermometer, which I had bent on at 3000 fathoms. With the remainder of the line I have obtained some 500's, when our own lines could not have been employed to that extent; and on two occasions between Tristan d'Acunha and this (Cape of Good Hope), I obtained 900 fathoms and 1500 fathoms with thermometers attached, saving them each time, and showing that 40° is the minimum temperature after 200, where it averages 50 and 52, no matter what the surface temperature may be. I have still 5000 fathoms to play upon, before reeling up spunyarn again, which from our junk I had done to the length of 8 miles before I had the present."

We have no doubt the worthy Commodore will be much gratified with this disposal of his line. We need scarcely assure him that such generous marks of friendly feeling cannot fail to be appreciated, and particularly so, when it is considered that he was giving away the means by which he himself might have gained the credit of finding the greatest depth of the ocean yet attained. But noble minds are above such personalities. The bottom was reached, and that was sufficient.

We shall leave our readers to form their own conclusions on the experiment, as to the up and down depth, as a seaman would say. But we may add, that although the experiment was made in a favorable part of the South Atlantic Ocean, we cannot suppose it possible that the ship would remain for the nine hours during which it lasted in a vertical position immediately over the lead, although nothing is said by Captain Denham as to the direction in which the line grows as the ship drifts while the operation is going forward, nor whether the boats and the ship were separated by the effect of any current. We by no means impugn the statement that bottom was reached when 8¾ statute miles were out, but should like to know whether or not some deduction should be made for drift, and what that should be, before an up and down depth can be asserted.—*London Nautical Magazine.*

Outlines of the Science of Mechanics.

No. 1.—Force.

Definition—Direction and Amount—Gravity the Standard of Force—Instantaneous and continued Forces—Uniform and variable Forces—Statics, Dynamics, and Mechanics.

Pupil. I find the word force used in a variety of combinations, and often with different significations. I wish to know what is intended by the word as used in mechanical science?

Teacher. A force is a pressure or tendency to produce motion. When by any cause an object is pressed either toward or from a given point, that pressure is a "force" acting on the object.

P. But suppose the object be so situated that it does not move in obedience to it, is the pressure tending to move it still entitled to the name of force?

T. It is. Force has been correctly defined as something changing or tending to change the state of a body with regard to motion or rest.

P. What points are of chief importance in considering the simple element force, as at present defined?

T. Two; direction and amount. The direction may be designated in any suitable manner: the amount may be expressed by figures which show its amount as compared with a certain standard. The standard universally adopted is gravity.

P. The force of gravity is a very common term. I understand you to mean, that weight or gravity is a force, and is used as a standard for comparing the amounts of forces—am I correct?

T. Yes. This lead weight in my hand is said to weigh one pound. This expression means that the natural attraction of the earth acts on it with a certain amount of force which we have agreed to call a pound. This amount is used as the unit for measuring the gravity of other bodies. Pounds, ounces, tons, &c., having become definitely established, it is convenient to compare all forces by the same standard with regard to amount, whether their direction be upward, downward, or in any other direction.

P. Very good. I find by this spring-balance that the weight of this hammer is 2 pounds. The *direction* of the force of gravity acting on this hammer might, therefore, be represented by an arrow or other index pointing towards the centre of the earth; and the *amount*, by the figure 2 indicating that it is twice as great as that which we have agreed to call one pound.

T. Correct. The most common instruments for comparing weights are scales, steel-yards, &c.; but the spring-balance has the advantage of applying equally well to other forces.

P. Here is a cord stretching across the room. Now, I detach the end from the fastening and secure it to the hook, so that the strain on the cord tends to extend the spring. In fact, the spring-balance is now a part of the cord, and bears an equal strain. Now I have drawn the cord to the same position and the same strain as before, and the index indicates 28 lbs.; so I conclude that the tension of the cord, or, in other words, the force with which the cord pulls on the fastening, is equal to 28 lbs.

T. Very good. Go on.

P. I noticed, when we were being towed up the river in the skiff, that you unfastened the tow-rope from the bow and introduced the balance in the same way—was that for the purpose of ascertaining, by experiment, the force with which the boat was being pulled by the rope?

T. It was. There are many cases in which a spring-balance will serve to ascertain approximately the amount of a force, careful regard being had to all the conditions in the case.

P. Some writers make a distinction between a pulling and a pushing force, calling each by Latin terms; is this important?

T. It is not of any vital importance. In almost every case it is sufficient to indicate the direction and amount of a force without reference to the question, whether the cause of the force is on one side or the other of the object to be affected. In moving cars short distances on a railroad track, it is sometimes necessary to employ the muscular strength of men. If a man exerts a constant force of 100 lbs. tending to move the car along the track, it is quite immaterial whether he stands before it and exerts a pulling, or behind it and exerts a pushing force.

P. Some authors make a distinction between instantaneous forces and those which are continued—is this important?

T. Yes; it is an important error! The doctrine of forces producing an effect by acting for an infinitely short time and through an infinitely short space, is a fallacy.

P. I think I have seen a distinction made between uniform and variable forces—is this important?

T. It is in a high degree. The natures of these distinctions are indicated by the terms themselves. So long as a force continues to be of the same amount, it is a uniform or constant force; but when it increases or diminishes, or both, either regularly or irregularly, it becomes a variable force.

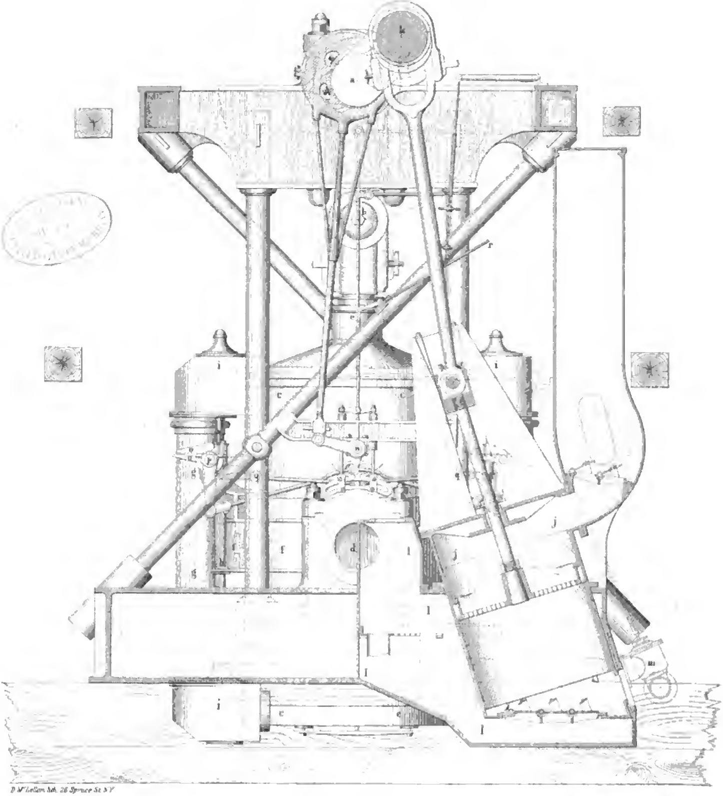
P. The force of gravity is a uniform force, is it not? I am aware that the attraction of the earth decreases as we rise above its surface; but within reasonable heights I imagine it to be very nearly uniform.

T. It is. Gravity acts with equal force on this leaden bullet under whatever circumstances it may be placed. If immersed in water it will not feel as heavy, or appear as heavy when tested by the balance, as before, but it is really attracted by the earth with the same force. Were it immersed in mercury, it would be entirely supported and would float on that heavier metal, but the force of gravity would not be diminished in the least. The nature of buoyancy and the phenomena of floating will be explained on some future occasion. If the bullet were in rapid motion through the air, as when discharged from a gun, it would still be acted on by gravity with the same force as now. If I hold it at an elevation, and release it from my hand, gravity instantly sets it in motion towards the earth; but it does not stop with thus setting it in motion: it continues to urge it, giving it still greater and greater speed, until it strikes the earth. Gravity also acts in the same manner, but with a reverse effect, when the bullet is thrown perpendicularly upwards by the hand: gravity continues to act upon it, diminishing its velocity, until it is completely stopped, still continuing to press it downward, the bullet then descends with a constantly-increasing velocity towards the earth. No velocity can be given it in any direction which will relieve it from the force of gravity. Even if the musket were pointed towards the earth and discharged, gravity would still act upon the mass of lead in its rapid descent, and endeavor to increase its speed. Gravity acts with the same amount of force whether a body is at

ENGINES OF THE U. S. MAIL STEAMER

GOLDEN GATE

SIDE ELEVATION & SECTION *thro' air pump*



D. M^c^Lellan lith. 26 Spruce St. N.Y.

Scale of feet

rest or in motion. There are few, if any, other forces which are thus uniform, and some even vary while the object acted on is so confined as not to be moved.

P. I cannot call to mind any examples of variable forces acting on a body at rest. I see plenty of examples of variable forces acting on bodies which yield to the force. Magnetic attraction, I fancy, is one of these. When the magnet draws a piece of iron towards itself, I find that the force increases as the iron approaches the surface of the magnet, and when quite in contact, it becomes of greatest amount. In drawing a companion on a sled by the force of my own muscular strength, I am generally able to exert a considerable force in starting, but as the sled gathers way, the force which I am able to exert diminishes, until at a considerable velocity I am barely able to keep the lines stretched. I suppose I might exert a force of twenty lbs. on the lines in starting, which would gradually diminish to one lb., or even less. Therefore, I am perfectly convinced of the existence of variable forces, but I do not think of any which are so except when motion is produced. Most forces, I think, are constant until motion is produced, and then instantly become variable. The force of the magnet acting faintly on the iron at a distance, or powerfully when close at hand, is uniform so long as the relative positions of each are maintained. The jaws of that vise, forced together by the screw, maintain the same pressure, I presume, so long as they are held there; and the force by which that wedge holds asunder the particles which it has separated, I suppose to be the same now that it was last year when it was first driven. The force exerted by the wedge would rapidly diminish to nothing, should the substance yield; but until it does so, I think its force is uniform or nearly so. Can you suggest any good examples of variable forces, except when motion is produced?

T. Strictly speaking, no force is uniform. Even weight, the most uniform within our command, differs, as you correctly intimated, for each variation of altitude, and also for each variation of latitude, and for each hour of the day. The language used in these inquiries is not to be understood as adapted to such extreme niceties, though accuracy is always desirable, and will be attempted at a more advanced stage. As a ready example of such a variable force as you require, I would select that hoop of ash, which has been bent for several days. The elastic force with which it tends to regain its original straight form is less than at first, and will be still less to-morrow. So you see that elasticity is in this case a variable force. Just across the way is a still stronger example of variable force. That refractory young tree has a rope stretching from its top to a stout post fixed in the ground at a little distance. With every gust of wind the force acting on the rope changes its amount, varying perhaps from 75 to 500 lbs. every few seconds; yet the rope does not move to any appreciable extent, and the force cannot be said to produce motion. Muscular force is also variable at will, and often independent of the will when long continued, whether the object acted on yields or not. Machinery is full of points in which the stationary parts are subjected to constantly-varying forces without motion being produced thereby; but this cannot be fully and clearly comprehended until some other elements of calculation have been presented. Machines and other structures present continual examples of *pounds of strength* or *pounds of force*, so to speak, existing in different parts, ready, when called forth, to exert forces in almost infinite variety. The face of the anvil is always ready to develop an almost unlimited force against the hammer, which will be uniform, variable, or otherwise, according to circumstances. Terrestrial mechanism is full of such cases, which constitutes the great point of difference between it and celestial mechanism or astronomy. In the latter, all bodies are free, and under very different circumstances from those which are partly confined and obliged to conform to certain grooves and curves. But, elasticity, &c., aside, the "pounds of force" alluded to neither produce nor destroy motion, although they often very materially change its direction.

P. It seems to be a matter of considerable importance to distinguish cases where motion is or is not produced or generated by a force. The study of pressures, where every thing remains stationary, seems comparatively easy; but where there is a perpetual yielding, the subject becomes much more confused and complicated. In other words, a force which assists in producing motion seems to exist under very different circumstances from one which does not. Is there not some short term or terms expressing the conditions in these respects?

T. Yes. The consideration of the cases where motion is not produced is called "Statics," and a force existing under such circumstances is sometimes called static force, static pressure, &c. This does not necessarily imply that the force is of a different kind or from a different cause, but the term is simply a condensed manner of expressing the fact that the pressure or force is of no effect in producing motion. Statics has been subdivided—*Geo-statics*, applying to solids; *Hydro-statics*, to liquids; and *Aero-statics*, to air or gases. *Pneumatics* is often used in place of the latter term, and is applied in a general way to all cases involving the properties of gases mechanically. The terms generally applied to the study of cases where motion is produced—a study which you justly consider as much more complicated—are *Dynamics*, *Mechanics*, and *Hydraulics*. The latter applies to the motion of liquids; "Mechanics," to those of solids, particularly when partly confined and partly free, as is generally the case; and "Dynamics" is often applied in a general manner to all cases where motion is produced, retarded, or modified by forces.

P. Are these terms important?—if so, will you give one or two familiar examples?

T. The terms are important, though not as much so as our principal term, force. Force is pressure, or tendency to motion; statics is a branch of science, and treats of forces which are balanced or confined; dynamics and mechanics are branches treating of those which do actually produce or destroy motion. That set-screw yonder exerts a static force: it does not push away the metal which it presses so tightly against. The pressure of the water in the mill-pond is static, or rather hydro-static, against the sides of the flume, but becomes dynamic or hydraulic, when it presses against the floats of the water-wheel and turns it. The pressure of steam against the inside of the boiler is static; it produces no effect: its pressure against the sides and end of the cylinder is also static; and its pressure on the piston even is static, until it becomes powerful enough to overcome the resistances and produce motion.

P. We have now touched on all the points of importance, I suppose, which are necessary to a tolerable understanding of simple force. Is there any thing more to be said before entering on the combinations of force with space, time, &c., in producing or affecting motion?

◆

Engines of the Golden Gate.

(*Description of the Plate.*)

a Main shaft.

b Crank-pin.

c c c c Cylinder.

d Trunnions on which the cylinder oscillates to accommodate itself to the motion of the crank.

e Stuffing-box on the cylinder-head. This is made as long as practicable, to give as much bearing as possible for oscillating the cylinder.

f f Belt-passage connecting the trunnion with

g g Side-pipe.

h h Valve-stems connecting with the balance puppet-valves in

i i i Valve-chests. The lower valve on the right or steam side is concealed by

j j j j Air-pump. The air-pump bucket is provided with india-rubber valves, and is worked by

k Crank on the intermediate shaft.

l l l l Condenser. There are two condensers and two air-pumps, They are located between the cylinders and inclined towards each other, one only being represented.

The passage *f f*, together with the side-pipes, valve-chests, and appurtenances, are fixed to the cylinder, and oscillate with it, the steam being received through one trunnion and allowed to escape to the condenser through the opposite one.

m is an injection-cock admitting the water upon a scattering plate in the condenser.

One leading feature of these engines is the application of balance puppet-valves—these being the first oscillating engines to which they have ever been applied; and the constructors, Messrs. Stillman and Allen, deserve great credit for attempting, and so successfully carrying out so decided an improvement.

The valves are worked by the toes *o o* in the usual manner. The rock-shafts *p p* receive motion partly from the movement of the cylinder, and partly from the eccentric. Levers are permanently attached to the trip-shafts *q q*, the ends of which work in a slotted piece curved to the centre of the trunnion. This piece is guided, as represented in the engraving, by vertical rods sliding in bushes attached to the fixed framing, and is connected by a rod to the starting-lever *r*, all the levers for working by hand being so balanced, that the engineer with one hand can work the engine up to the usual speed.

The cut-off valve is placed outside the trunnion, and is a balance puppet-valve, worked by the ordinary cam motion, and so arranged as to act either as cut-off or throttle, or both, the levers being placed within reach of the engineer when working the engine.

The Golden Gate has four return tubular boilers—two forward and two aft of the engines. They are placed at the sides of the ship, leaving room for the fire-room in the centre. The furnaces are consequently athwart-ships instead of ranging fore and aft as usual.

The performance of the G. G. has been highly satisfactory. She is now running between Panama and San Francisco, and is considered the fleetest steamer in the Pacific. In addition to this ship, the Illinois, plying between this city and Chagres, the John L. Stevens, new—(see dimensions, &c., page 23)—the Augusta, also new, plying between this city and Savannah, the Republic, and the Agnes, a vessel constructed for the Spanish government in 1850, are American examples of paddle-wheel steamers fitted with oscillating engines. The ponderous side-lever engines with which, in prudent imitation of English examples, most of our earlier ocean steamships were provided, are considered by many American engineers as almost obsolete—the oscillating and the ordinary beam engines, the latter especially on account of its economy, being most in favor for paddle-wheel steamers. Oscillators possess a compactness not obtainable in any other short of a rotatory form, and are found in practice to present few of the difficulties which might be reasonably anticipated. The friction and consequent wear and heating of the trunnions, the oval wear of the piston-rod, stuffing-box, piston, and cylinder, have in no case proved to be of any serious account.

The Golden Gate is of the following principal dimensions: Length on deck, 265 feet; beam, 40 feet; depth of hold, 22 feet; tonnage, 2030 tons; diameter of cylinders, 85 inches; stroke, 9 feet; average revolutions, 18¼; average pressure in boilers above atmosphere, 12 lbs.; cut-off from commencement, 3 feet; amount of fire surface, 12,052 square feet; tube surface, 8396; grate surface, 367; calorimeter of tubes, 61¾ feet; paddle-wheels, diameter 31 feet; length of paddle, 12 feet; depth, 24 inches; number of paddles in each wheel, 30.

LIST OF PATENTS,

Issued from the U. S. Patent Office during the month of February, 1853.

J. B. Monier and P. H. Boutigney, of Paris, France, for improvement in Purifying Fatty Matters.

Claim.—The introduction and mingling of a current or currents of sulphurous acid gas with mixtures of fatty acids and alkalies, preparatory to the process of being converted into candles, tapers, and articles for burning, thereby rendering such mixtures of a superior quality, and causing them to burn with a stronger, clearer, and brighter light.

N. A. Boynton, of Boston, Mass., for improvement in Hot-Air Furnaces.

Claim.—I do not claim a hollow ring radiator placed over, and made to communicate with the chamber of combustion; but I claim the hollow wheel radiator, made with a hollow rim, hollow spokes, a hollow hub (open at top and bottom), and a valve and valve-seat so made and applied to the hub, that when the valve is closed, it shall cause the heat and volatile products of combustion to pass through one or more of the arms, and into and through the hollow rim, out of the said rim, through the other arm or arms, into the hub and over the valve, and also, so that when the said valve is opened, the heat and volatile products of combustion may pass directly up through the hub, without first circulating through the hollow arms and rim, as specified.

Geo. Chase, of Prudence Island, R. I., for improvement in Centre-Board and Rudder for Shoal-water Vessels.

Claim.—I am aware that one rudder, made to slide within the other, and attached to a centre-board, has been used, so that one shall rise with the other, but in this case there is no indication by which it can be known, when the sliding rudder is up or down, and when used.

I claim attaching the rear end of the movable centre-board and the rudder of the sliding stern-post, so that the said centre-board, stern-post, and rudder, may be raised or lowered together, substantially as described, and by which means I only use a single rudder whose position can always be known by the height of the stern-post to which it is hung, as also that of the centre-board, the sliding stern-post serving as an indicator of the positions of both.

John Filson, of Milroy, Pa., for improvement in hanging Farm Gates.

Claim.—The lower double-jointed hinge, in combination with the apparatus attached, and constituting the upper hinge, as described, for the purpose of holding the gate at any inclination required, for the purposes set forth.

Geo. Peacock, of West Troy, N. Y., for improvement in Core-Bars for Casting Pipes.

Claim.—The core-bar having transverse wings or projections, of a semicircular or other shape, corresponding to the shape of the article to be cast, said wings or projections permitting the sand to be rammed, for forming the lower half of the core, and holding or binding the sand to the lower part of the bar, and allowing the upper half of the core to be made by the sweep, as set forth.

Also, the manner of anchoring the core-bar, as described, viz., by means of the metal strips and bridges fitting in recesses in the upper surface of the core-bar, said bridges resting upon wooden supports, and having anchor-rods bearing on their upper surfaces, the liquid metal burning out the wooden supports and allowing the core to be withdrawn, by which means the core is prevented from being raised or forced upward by the liquid metals, as it is poured into the mould, and thus enabling pipes to be cast of any desired length.

Also the manner, substantially as described, of connecting or jointing the core-bars, for forming cores for elbows or branch pipes, by means of wooden wedges, which are the means of holding the bars together while the core is being formed, said wedges being burnt out by the liquid metal, when poured into the mould, and allowing the cores to be withdrawn.

Chas. Peters, of Trenton, N. J., for improvement in Moulds for uniting Steel to Cast-Iron.

Claim.—The use of a solid base to moulds, in which steel or wrought-iron is to be welded to cast-iron, with an aperture in the same, so that by means thereof the said steel or wrought-iron can be subjected to the heat of the furnace while in the mould.

G. F. S. Zimmerman, of Charlestown, Va., for improvement in Winnowers.

Claim.—The invention, use, and application of the perforated vibrating-table, arranged to a sloping bottom or platform, the parallel, saw-like strips or straw-pushers, combined with an oscillating rake and straw-beaters or curved prongs, the whole combined and working with the oscillating hinged-standard and suspending-straps, substantially as set forth.

I do not, however, claim the invention of a combined threshing, separating, and winnowing machine, but only such parts as are set forth.

E. R. Hallam, of New Haven, Ct., and T. R. Barnard, of Brooklyn, N. Y., assignees to E. R. Hallam, of New Haven, Ct., for improvement in the Construction of Gas Meters.

Claim.—The method of constructing meters with one cylinder working within another, so that the gas passes alternately into the inner cylinder, and out of the space above it, and then out of the inner cylinder, while the supply enters the space above it, the gas being changed in its course or direction by valves, as described.

R. Le Riemondie, of New Orleans, La., for Surgical Instruments for the Ear, &c.

Claim.—The construction of an instrument for examining the interior of the ear, nose, eye, or other part of the human system, by the combination of the reflectors, the lens, case, tubes, and lamp, as specified.

Horatio Allen and D. G. Wells, of New York, N. Y., for improvement in Cut-off for Puppet-valve Engines.

Claim.—First, the combination of pawls, with the two arms, whereby the valves are lifted and tripped, as described.

Second, the combination of the arms provided with rollers which, in their action, assist in transferring the pawls from one arm to the other, with the pawls and loose toes, as described.

Third, the making the rollers adjustable with reference to each other, by means of supporting them on independent arms, and connecting them to each other and the arms, by means of a right and left screw, whereby the point of cut-off may be altered.

Fourth, the mode of operating the loose toes, by means of pawls and rollers, substantially as described.

Fifth, the mode of working the valves by hand, by means of toes supported on the rock-shaft, substantially as described.

John Briggs, of Boston, Mass., for improvement in Car Seats.

Claim.—A seat sliding in an arc formed in the frame-work of the chair, and fastened in any desired position, as set forth, whereby the back is made to follow the motion of the seat in such a manner as to preserve a constant or nearly a constant connection and angle therewith.

D. C. Brown, of Lowell, Mass., for improvement in Harness for Looms.

Claim.—First, the fliers constructed with a spring nose, or its equivalent, so as to yield the twine, when the needles draw the stitches into the rest, and to take up the binding twine, or draw it tight, when the stitches slip off the needles.

Second, the apparatus, or its equivalent, for shoving the eyes off the rod F, consisting of the cam J, slide D, lever, rod C, and slide E.

Third, the revolving spring-nose flier, or its equivalent, in combination with the needle, or its equivalent, for the purposes set forth.

J. C. Cary, of Richmond, Va., for improvement in Spike Machines.

Claim.—Sustaining the heading lever upon a movable fulcrum, so as to be capable of adjustment to the requisite distance inside or outside of a vertical line drawn, touching the plane of the face of the griping dies, for effecting the heading of the spike, either up or down, or otherwise in one single motion upon its fulcrum, as set forth.

R. M. Leslie, of Philadelphia, Pa., for improvement in Paging Books.

Claim.—First, the spring-slat type wheels, made after the manner and operating for the purposes described.

Second, the combination and arrangement of the spring-slat type-wheels, the adjustable posts, sliding-arms, spring-frame, inking-rollers, with their tables, and the rod K, with its ratchet and pawls, whereby I am enabled to number one side of four pages by a single movement of the treadles, as described.

L. F. Sheppard, of Alhambra, Ill., for improvement in Artificial Teeth.

Claim.—Extending a suitable metallic plate over the masticating portion of artificial teeth, to protect them more effectually against injury from use, substantially as set forth.

R. B. White, of Meridon, N. Y., for improvement in Saw-setting Machine.

Claim.—The combination of the spring-hammer, with the tooth-gage, both operating in the manner and for the purpose described.

David and Herman Wolf, of Lebanon, Pa., for Seed Planters.

Claim.—The moveble clearer, arranged in the manner and for the purpose set forth.

Hezekiah Bradford and Elisha Fitzgerald, of New York, N. Y., for improvement in mode of Separating Ores and other Substances.

Claim.—Giving to the reciprocating pan the peculiar motion described, by the means described.

Also, giving the back movement to the said pan, in a less period of time than the forward movement, by means of a crank or cranks, whose axis of motion is below or above the plane of motion of the rear end of said pan, or by equivalent means, as described, and for the purpose specified.

Also, in combination with a pan, having the motions, or either of the motions, substantially such as specified, and on which the ore, &c., mixed in water, is supplied at some point towards the middle or back, the employment of a current or currents of water descending the inclined or curved surface of the said pan, as specified.

Also, making the rear end of the said pan with an inclination or curve upwards, as set forth.

Also, making the said pan, as specified, with apertures back of the place where the substances to be separated are applied, for the purpose set forth.

Finally, making the front and rear ends, or either, of the pan having a vibratory motion, with a gradual curve downwards, as specified, when the same is employed, in combination with currents of water, as specified.

A. A. Croll, of London, England, for improvement in Gas Meters.

Claim.—The mode of arranging movable partitions or plates, so that the flexible material at the circumference of the plates shall not be bent but in one direction, as set forth.

Also, the arrangement and combination of the arms, with the valves and movable plates of a dry meter, as set forth.

W. A. Johnson, of Greenville, Mass., (assignor to W. G. Bates, of Westfield, Mass.), for improvement in Sewing Machines.

Claim.—The making of the double loop-stitch, having the loops upon one side of the cloth, by means of two needles, combined and operating as described.

Also, the making a seam, or uniting two pieces of cloth, by means of the double loop-stitch, consisting of a plain stitch from a single thread on one side, and on the other, of a continuous chain formed of a succession of double loops from the threads.

Alpheus Kimball, of Fitchburgh, Mass., for improvement in Scythe Fastenings.

Claim.—The method of securing the blade of the scythe to the snath, by passing its shank through the end of the stationary metal cap, and securing it by means of the upward pressure of the screw, in combination with the claw and bush-piece, constructed and operating as described.

Wm. S. Lacon, of Great Yarmouth, England, for improvement in Suspending, Lowering, and Liberating Ships' Boats. Patented in England Feb. 23, 1852.

Claim.—I do not confine myself to the precise arrangement of apparatus described for carrying out my invention; but I claim suspending ships' boats by having the chains or ropes so connected with drums or barrels, substantially as specified, that the two ends of the boat shall descend together, and with equal or nearly equal velocity, and so that the chains or ropes shall be free to disengage themselves from the barrels, in combination with the mode of controlling the turning of the barrels by the weight of the boat, &c., as specified.

By James Moreland, of Adrian, Mich., for improvement in Mortising Machines.

Claim.—The combination of the cross-bar on the cross-head, with the projecting dog on the moveble way, for the purpose of withdrawing the chisel from the wood, on the back motion of the cross-head, as set forth.

By A. B. Taylor, of Mystic, Conn., and Stephen Wilson, Jr., of Westerly, R. I., for improvement in Cut-off Motion for Looms.

Claim.—We do not claim the roller against the warp, by which the position of the weight is regulated; neither do we claim the ratchet-wheel and worm-pinion, moved by a pawl or click from the lay, as these have before been used.

What we claim is, effecting and regulating the let-off motion by the variable counterpoise lever, in combination with the sliding worm-pinion, when said worm-pinion is acted on by the yarn beam through a direct strain communicated to it by the tension of the warp, the whole arranged and combined, as specified.

Lauren Ward (administrator of Richard Ward, deceased), J. B. Hubbell, and H. C. Hubbell, of Naugatuck, Ct., for improvement in Turning Irregular Forms.

Claim.—We are aware that machines have been made for turning irregular shapes, by means of sliding centre-grooves, guides, patterns, cams, &c., and that cutters have been so formed and arranged as to assist the cams, &c., in giving the shape to the article, we therefore do not claim either of these, as such, as our own invention; but we claim the use of the cutter-wheel for turning irregular forms, the cutters being so arranged that the pattern may be disclosed in reverse, on its surface, when combined with the feed motion described, so that in turning said cutter-wheel, the desired irregular shape will be given to the article, without using guides or patterns, when the whole is combined and made to operate as described.

Asa N. and Alden Case, of Gustavus, Ohio, for improvement in Bedstead Fastenings.

Claim.—We do not claim the pawl and ratchet; but we claim the combination of the inclined plane and head, with the pawl and two ratchets, for the purpose of fastening bedsteads and tightening the cord, as specified.

A. C. Harig, of Louisville, Ky., for improvement in Swivel Nibbed Keys for Door Locks.

Claim.—I am aware that the nib of the key has been fitted into the tubular shank, and so secured therein by a pin fitting into a groove, that the burglar's instrument, when applied to the nib, would rotate it without moving the key; also, that the key, by a plate attached to the inner lock-plate, has been held so that it could not be rotated; but I claim the guard-bit attached to the swivel nib in combination with the ordinary bit and shank of the key, constructed and operating as set forth.

James McKay, of Philadelphia, Pa., for improvement in Rotary Steam-Engines.

Claim.—The passages for the exhaust steam, arranged so that they shall cover and encircle the entire periphery of the stationary cylinder, and have their ingress and egress openings so arranged as to cause the exhaust steam, as it escapes, to envelop the whole surface of the cylinder, as described.

In combination with the ordinary valves and parts which form a passage for the steam to and from the engine, I claim the supplemental exhaust parts and valves, which act in conjunction with the ordinary exhaust-valves, whereby a free egress for the exhaust steam is afforded without leaving large open passages for the steam to waste in.

Also, the combination of the sliding pistons, with self-adjusting valves and steam-ways, which admit a portion of the steam which propels the piston, behind its inner end, to act as a spring to press it out into the steam-space, whichever way the engine may be turning.

Also, mounting or hanging the two cylinders on radial and axial journals respectively, arranged in a common plane, and at right angles to each other, whereby the two cylinders can accommodate themselves to each other so as to avoid binding, as set forth.

Wm. Townshend, of Hinsdale, Mass., for improvement in Looms.

Claim.—I do not claim actuating the pickers by the backward motion of the lay alone; but, first, I claim the cam-wheel on the chain-shaft, right-angle lever, and staples or slide-bolts, combined and acting as described, to bring the picking motion into operation alternately on each side by the backward motion of the lay, as specified.

Second, actuating the picker-staffs by the lay on its backward motion, by means of the vibrating-studs, when combined with levers attached to the swords of the lay, and two bent levers, arranged and combined in the manner described.

Third, the two levers are connected together by the adjustable pin so as to give greater or less motion to the selvage-warp, when actuated by the cam, as described.

Fourth, the apron or straps connected to the bar, and kept to the cloth by proper weight or power, so as to cause sufficient friction to wind the cloth on the cloth-beam when said apron and bar are moved or actuated from the lay or otherwise, so as to produce the effects herein described.

Jonas Simmons, of Cohoes, N. Y., for improvement in Machines for Making Axes.

Claim.—I do not claim the employment of rolling dies for shaping an axe; but I claim the arrangement of the rolling dies with a rest-bar to support the iron whilst being rolled, and an eye-bar, arranged not only to serve as a mandrel to shape the eye of the axe, but with the rest-bar to hold the iron firm during the process of rolling, the rest-bar and eye-bar being connected with the machinery to give them appropriate movements, to cause them to co-operate with the rolls in shaping the axe, and these parts, further in combination with a scarfing-bar, for the purpose of shaping the blade to receive the steel point in order to complete the axe, substantially as set forth.

Chas. A. Spring, of Kensington, Pa., for improvement in Supplemental Valve in Reciprocating Steam-Engines.

Claim.—The arrangement of a valve in the lid of the steam-chest, or the equivalent thereof, between the cylinder of a steam-engine and the boiler, in such manner that it will prevent the reflux of the lead-steam by closing, whenever the pressure of the steam in the engine excludes that in the boiler, and opening again whenever the pressure in the boiler is greater, substantially as herein set forth.

E. Sumner Taylor, of Cleveland, Ohio, for improvement in Bedstead Fastenings.

Claim.—I do not claim separately the pawl and ratchet, nor a continuous right and left hand screw; but I claim the combination of the pawl and ratchet with the spiral-grooved sections attached to the tenons, arranged and applied in the manner and for the purpose herein specified, namely, the tenons of one side-rail and one end-rail, being furnished with the plate, having the spiral groove turning to the right and left as described, making a tight joint with the post; the other side and end rails having on their tenons a groove passing around the tenon at right angles to the axis and fitting the pins, as described, so that by having one side of the tenon on each end flattened to enable it to pass the pin, in order to allow it to enter the groove, when, by turning in either direction, less than a complete revolution, the pin fitting into the groove prevents the posts and rails from separating, and by attaching the ratchets to the end of this side-rail and one end of the end-rail, with the pawls attached to the posts as specified, by tightening of the cord put on in the manner described, the whole frame of the bedstead is held firmly together by the combined action of all the parts described, one end-rail and one side-rail remaining stationary, the other end-rail and side-rail turning, as described, for the purpose of tightening the cord, both being secured by the pawl and ratchet.

By Wm. Wheeler, of Troy, N. Y., for Improvement in Curry-Combs.

Claim.—The application of a ring, loop, or fixtures on curry-combs, for the insertion of a thumb as a guard or rest therefor, the ring or loop being made in one piece with the back strap, as set forth.

RE-ISSUE.

Ed. Hamilton, of Bridgeport, Ct., assignor to H. B. Goodyear, administrator of Nelson Goodyear, deceased, for Excluding Dust from Railroad Cars.

Claim.—Inducing outward currents of air through the windows of railroad cars to prevent the entrance of dust, &c., by the action of the surrounding air on deflectors, combined with the sides of the car, substantially as set forth.

Nehemiah Hodge, of North Adams, Mass., for improvement in Brakes for Cars.

Claim.—I am aware that the brakes of a car made with trucks or truck-frames have been connected in different ways, so that the brakes of both trucks could be brought down simultaneously upon the wheels by the action of either windlass.

I therefore do not claim any machinery for doing merely this, but when this has been done, the machinery applied to the windlasses and brakes of the trucks has not been such as to cause, under all, or nearly all circumstances, while the car is in operation, or running on a railway track, in which there may be curves or deflections from straight lines in the laying of its rails, and when either windlass is put in operation, the like amount of force which may be brought to act upon the brake-lever of one truck, to act (through moveable rod or connecting mechanism) upon the brakes of the opposite truck.

I therefore claim my improvement in actuating the brakes of a car having two trucks; that is to say, a combination of four levers and three rods, as applied to the brakes and two windlasses of the car, and operated by either of the windlasses so as to bring down at the same time the brakes of both trucks upon the wheels thereof with the same, or practically the same degree of force, and whether, when the car is running on the railway, the axles of one truck or the wheels of one truck are thrown or moved out of parallelism with those of the other truck, or the rubbers, or the brakes become unequally worn, or of an unequal thickness, as above stated.

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The Mechanics' Magazine and the Caloric Engine.

We have received, at a late day, a letter from Capt. Ericsson complaining in strong terms, and with much display of feeling, of a disposition on our part to check the development of his invention. We can readily forgive the personal indignities of which he is lavish, in view of the facts and important corrections, which his letter contains, of our previous vague and unreliable information. Being aware of the intense interest with which this experiment is regarded by the engineering and the mercantile world, and of the important effect which a decisive result would have on the future direction and development of mechanical and engineering skill, we have published each month all the facts connected with the subject, which we have judged of importance, and have, in many cases, attempted to approximate to what we had no means of ascertaining with certainty; but have distinctly stated, in each case, the probability that such details were more or less in error. These approximations may not have been highly appreciated, but may possess some value when placed in contrast with the utter ignorance which would otherwise exist, at a distance, and among those who have no opportunity for information, except by the published accounts. The most respectable of our southern and southwestern exchanges give the Ericsson ten miles per hour against the tide; and a very high London authority, an eminent mechanical work, made one wheel of the ship to revolve "by the unaided action of the apparatus upon the atmosphere—no fire being used." Our readers will hardly consider necessary a disavowal of any disposition to check the development of the caloric engine. Privately, we have felt no such disposition, and publicly have expressed none. In October, 1851, [vol. 1, pp. 590 to 594 inclusive,] were published two elaborate wood engravings, and a full description, so far as the invention was then known, including the patent claims, &c. It was further alluded to by correspondents, always more or less favorable, till Sept., 1852, [vol. 2, pp. 208 to 210,] when two highly favorable notices were copied, and illustrated by engravings; one from the Boston Transcript, describing the present ship, and the other from the London Mechanics' Magazine, explaining the principle. In November, 1852, [vol. 2, pp. 259 to 261,] was presented a sketch of the early life and extraordinary talents of this justly distinguished engineer, and also an outline of the early history of the caloric engine. This was highly friendly, if only by reason of its properly noting the skill, and omitting to notice the many practical failures in his inventions. With the commencement of the third volume, appeared a brief notice, stating our interest in the subject, and desire to fully present it, and also distinctly but briefly stating what appeared to us the principal point in which to apprehend a failure. In the February number was an accurate plate, half-inch to the foot, of the stationary, the ship-engines not being obtainable, and the fullest information which could be procured from any legitimate sources concerning the engines, but denying that a successful trial trip had yet been made, and in the March No., an article on the possibility of explosion, and some additional approximations and calculations, an important element of which was the dimensions of the grates. For some reason, although no movement of the engines was attempted, the furnaces were all fired while the visitors were on board, and no accurate observation could be made of the grates. The dimensions given were distinctly stated at the time as measured by the eye under these disadvantageous circumstances, and although, by the statements below, the area was in error, nearly two to one, it only argues our weakness in that very important faculty, judgment of dimensions. The engineering world will justify our course to the fullest extent, as the only correct one to be adopted with regard to an experiment in which there was a possibility and probability of success. We have encouraged the enterprise in the same manner as we do others, and have forborne any decidedly unfavorable opinion until the final and decisive experiment had been performed, officially announced as successful, and our Government solicited to construct naval ships fitted with these engines. Even now, we give no opinion unaccompanied by the reason therefor, based on the facts as we can obtain them.

We wish distinctly and fairly to yield one question, raised with some doubt in our last issue, in regard to the harmless effect of intensely heated air on the animal tissues. It is of little importance with reference to the main question (the rapid and economical generation of power by different varieties of well-managed motors), but is a physiological inquiry of considerable interest. The caloric engine is quite liable to accidents, but we are satisfied that such accidents must be comparatively harmless to human life. The fact that steam condenses and parts with its latent as well as sensible heat in the lungs, is sufficient to account for its remarkably fatal effects, and no experiments, within our knowledge, have yet determined the temperature at which air becomes immediately fatal, if, in fact, it is so at any degree. The specific heats of air and of steam, are of trifling consequence in comparison with the latent heat of the latter, which is certain to become sensible when in contact with delicate cuticle or membrane.

Omitting the personal matters, we present the letter entire:

"You state that the furnaces of the caloric ship present 180 square feet of grate surface—this is not true—they only present 76¾ square feet. You assert that forced blast may be resorted to, to such an extent that *eighty* tons of coals may be consumed in the caloric ship in 24 hours. This assertion is untrue; no forced blast whatever can be applied, nor can the consumption exceed *eight* tons in 24 hours, the chimneys being only 30 inches diameter, and 12½ feet above deck; small passages were originally formed for passing air from the exhaust-pipes, under the furnaces, in case the powerful suction of the engines should be found to produce a back draught; such a difficulty not having been experienced, the passages alluded to were long ago[*] closed with brickwork. Your assertion, therefore, is groundless, and you fall short of the truth in the ratio of *ten* to *one*.

You next state that we have only *fifty*[†] wire disks in each of our regenerators, composed of wire-cloth of four[‡] meshes to the inch; this is equally untrue, for we have *one hundred and fifty* disks, and only half of this number is of the kind you mention, the remaining half being much finer. According to your statement, our regenerators would only present about 4800 square feet of heating surface, whereas they actually present upwards of 15,000 square feet; laboring under this gross error, you draw the inference that our regenerators are of little use, &c. Now, the *fact* is, that our regenerators in the caloric ship are singularly effective, the temperature of the air in the exhaust-pipes never having reached 31 degrees above that in the conductors from the supply-cylinders!"

"You broadly assert that the quantity of fuel consumed in the caloric ship has not been ascertained, and you brand our great demonstration as a failure; now the fuel *has* been accurately weighed, and the consumption found to be 4½ tons in 24 hours, effecting a speed of more than seven miles an hour: that you call a failure! Is there a steamship in existence, of the size of the Ericsson, capable of going at that rate on twice the stated consumption? Let me state a fact here which has not yet appeared before the public. The elasticity of our wrought-iron heaters has been found so great, that during our trials, and during our trip to Washington, we did not venture to average more than 7½ pounds pressure per square inch; *cast*-iron heaters are now being made, to enable us to carry full pressure.

You state that my engine is nothing but a copy of Stirling's air-engine; or rather you state that which leads to that inference. Now it would be difficult to conceive two machines more dissimilar in action and mechanical construction; Stirling expands and contracts a certain volume of air, and thereby operates a working piston, the power of which is most precarious, as it diminishes the instant the piston moves; my caloric engine, on the other hand, resembles a high-pressure steam-engine; it has a pump and a working cylinder; the former charging a receiver, from which the latter receives its supply, like a steam-cylinder from the boiler. By the emphatic manner in which you place before your readers the discussion on Stirling's engine before the Institution of Civil Engineers in 1846, and call it "old," your readers are made to draw the inference that I am forestalled. Let us see how the case stands: in 1833, I put my caloric engine in operation in London, and submitted the principle of *employing heat over and over again* to the scientific world. Faraday and Lardner at first repudiated the idea, but soon became convinced, and lectured on the subject to large audiences. The celebrated Drs. Ure and Ritchie also became my warm supporters. Will any one contend, therefore, that I am forestalled by an echo, in the Institution of Civil Engineers, 1846, of the arguments which I had advanced 13 years previously?

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[*] The first and second trial trips in New York Harbor are the voyages for which tolerable speed is claimed; now, were those passages open, or were they not, on these trial trips?

[†] See Daily Tribune, Times, and Herald, Jan. 12, 1853, report of the second trial trip.

[‡] This important point was ascertained with regard to the outer ones, by examining the face presented towards the valve-chest, on Feb. 11th.

I will not take up your time by further discussion, simply observing, in conclusion, that the course of your journal, in regard to my important invention, and your endeavors to check its development, is at variance with the spirit of a progressive age. If you cannot *encourage*, then remain *silent*, or at any rate, if you will oppose me, then *speak the truth*, or the usefulness and respectability of your journal will be seriously compromised."

Aside from the dates of patents, of which it is believed that Stirling's dated 1827, and Ericsson's 1833, the whole matter of forestalling may be summed up as follows: somebody, possibly James Watt, Thomas Savery, or Archimedes, first *thought* of using heat several times. Capt. Ericsson, Mr. Stirling, or somebody else, first proclaimed the idea to the world; and somebody, we incline to think it was Capt. Ericsson, first built an engine—endeavoring to apply the principle. If, in our remarks in the March number, the impression was conveyed that Capt. E. was behind Mr. S. in attempting to apply the principle, it was unintentional; we only say that Stirling was the first to put his machine in practical use, driving the Dundee Foundry a year or more, prior to 1846, while Capt. E. has never, to our knowledge, applied his machine to the regular performance of any work until the construction of this ship; and even now seems to prefer models and explanations of the principle to practical and definite performances. We hold that the time to discuss the *possibility* of such an application, was some 20 years ago; the question of the *probability* of its success, is still a fair subject for mathematical and experimental inquiry; but that, according to the statements of all the rival claimants of the invention, the whole problem for several years past has been simply to overcome the practical difficulties in the way of its application. To prove that these have not been yet overcome, in the case of the ship in question, we respectfully refer to her log-books, if they be made accessible, or, if not, to the admissions of Capt. E. and others, which have from time to time been made public. We consider her a failure so far, and will endeavor to answer his question with regard to coal and speed in our next issue. In the mean while, we again, in behalf of the mechanics and engineers of the world, respectfully invite from Capt. Ericsson, or any one authorized by him, any further definite information which we may be allowed to present.

Apprentices' Department.

Answers and Explanations of Questions on page 70.

5th. There is more water expended in case of a vessel ascending than descending through a lock, the difference being double the bulk of water displaced by the vessel.

To illustrate: suppose 100 measures represent the quantity in the lock when filled to the upper level; 20, the quantity when filled to the lower level; and 5 the bulk of water displaced by the immersed portion of the vessel. Then, when the vessel is in the lock, ready to descend, the contents of the lock will be 100 − 5 = 95, from which deduct the contents when level with the lower side, and you have 95 − 20 = 75 = expenditure of water in descending. When the vessel is in the lock, ready to ascend, the contents of the lock will be 20 − 5 = 15, which deduct from the contents when level with the upper side, and you have 100 − 15 = 85 = the expenditure in ascending; showing a difference of double the bulk of water displaced by the vessel.

Between a "laden" and a "light" vessel, there will evidently be a difference in proportion to the bulk of water they severally displace.

6th. The water required to fill the cylindrical cistern is 32,901 gallons; the weight of the same is 274,889 lbs.

Explanation.—Find, by problem 3, the area of the circle, of which 20 feet is the diameter; multiply this area by the depth, 14 feet, which gives the contents of the cistern in cubic feet. This contents, multiplied by $62\frac{1}{2}$, or 62·5, gives the weight of the whole; also the contents in cubic feet multiplied by 1728 (the number of cubic inches in a cubic foot), and the product divided by 231 (the number of cubic inches in a gallon), gives the whole capacity in gallons.

7th. The average velocity of the clipper would be 8 miles per hour. The relative velocities then would be: air-ship, $^7/_{15}$, and clipper ship, $^8/_{15}$, that of the steamship.

8th. 1*st.* The number of vibrations per minute = 12·515.

2*d.* The greatest velocity acquired by the "centre of oscillation," is at the *lowest* point of its path.

3*d.* The "*amount*" of its velocity at this point = 32·1511 feet per second.

4*th.* The *strain* on the ropes, when the persons swinging weigh 300 pounds, = 428·6095 lbs.

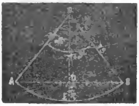
Solution.—Let T = time, in sec's, required to make *one* vibration.

" $\pi = 3{\cdot}1416$, = ratio of circle to diameter.

" l = length of rope, between centres of oscillation and suspension.

" g = force of gravity = 32·1808.

Then $T = \pi\sqrt{\frac{l}{g}} = 3{\cdot}1416\sqrt{\frac{75}{32{\cdot}1808}} = 4{\cdot}794^s$, and $\frac{60^s}{4{\cdot}794} = 12{\cdot}515+$, as above.



Arc A B = 100 feet.

$\text{Circ} = 2\pi \times \text{radius} = 2 \times 3{\cdot}1416 \times 75, = 471{\cdot}24$ feet.

$\angle ABC = \frac{100}{471{\cdot}24} \times 360 = 76^\circ\ 24'$.

$\angle DCB = \frac{76^\circ\ 24'}{2} = 38^\circ\ 12'$.

$DE = CE - CD$, $CD = CB \times \text{cosine } 38^\circ\ 12' = 75 \times 0{\cdot}7858569 = 58{\cdot}9392+$ feet.

$\therefore DE = 75 - 58.9392+ = 16{\cdot}0607$ feet.

The greatest velocity is acquired at E, and is equivalent to the velocity which would be acquired by a body falling through the vertical height DE.

Let $h = DE$, $g = 32{\cdot}1808$, and v = the velocity at E. Then $v^2 = 2gh$, or $v = \sqrt{2gh} = \sqrt{2 \times 32{\cdot}1808 \times 16{\cdot}0607} = 32{\cdot}1511$ feet per second.

The strain on the ropes is least at the point A and B, and increases towards E, where it is a maximum, and is equal to the weight of the persons swinging, plus the centrifugal force due to the velocity at that point.

Let F = centrifugal force at E; W = weight of persons swinging; g = force of gravity; and R = radius.

$$\text{Then, } F = \frac{W \times v^2}{g \times R} = \frac{300 \times 32{\cdot}1511^2}{32{\cdot}1808 \times 75} = 128{\cdot}6095 \text{ lbs.}$$

$\therefore$ Strain on ropes = 300 + 128·6095 = 428·6095 lbs. R. P. I.

Oriskany, Mar. 11*th*, 1853.

Questions.

Question 9.—The weight of cold fresh water is very nearly 1000 ounces per cubic foot. Required what weight of water will completely fill a cylindrical boiler 4 feet in internal diameter and 30 feet long; deduction being made for two flues running lengthwise through the boiler, each 15 inches outside diameter?

Question 10.—The specific gravity of cast-iron being 7·207 (water being 1). Required the weight of a casting, 28 feet long, 6 feet wide, and 3 inches thick?

Question 11.—A certain bowling alley is four feet wide, and the surface, though perfectly plane, is inclined transversely to its length to the extent of ½ inch to the foot; in other words, the surface is a half inch lower on one side than on the other. Now, if a ball weighing 10 lbs., and of a diameter equal 8 inches, is rolled with a velocity of 30 feet per second, and aimed directly at the centre of a pin 6 inches in diameter, will it hit the pin, and if not, by how many inches will it clear it, supposing the distance to be 60 feet?

Correspondence.

[For Appletons' Mechanics' Magazine.]

"DOES MELTED IRON EXPAND IN SOLIDIFYING?"

In the American Railroad Journal, for Sept. 22d, 1849, appeared a review of "Mushet on contraction and expansion of cast-iron."

The apparent anomaly of solid cast-iron floating upon liquid cast-iron was a prominent question, viewed as a universally admitted fact. I then pursued a series of experiments which seemed to establish the anomaly, and the difficulties connected therewith remained unexplained. The subject having been recently pressed upon my attention, I have again experimented, and, in every case where the piece of iron has been *really solid*, or, without any foreign admixture, it has sunk in the liquid to the bottom, and has there been felt with a rod until it has been acted upon by the heat and itself resolved into the liquid.

The supposition of the liquid floating the solid iron, is the main foundation upon which Mushet has built his theory of contraction and expansion; to which theory he has distorted many phenomena of every day's occurrence to the founder; the rationale of which perfectly harmonizes with the fact, that iron is most dense when cold, and continues to expand with every additional degree of heat to which it is subjected.

N. M. Stratton.

Novelty Iron Works, New York, Mar. 29, 1853.

To the Editor of Appletons' Mechanics' Magazine.

Owego, Tioga County, N. Y., *March 15th*, 1853.

Dear Sir:—As you invite questions for your valuable magazine, I am encouraged to propose the following:

It is well known that when rivers *are rising*, in times of freshets, and have a rapid current, the surface of the water *is higher* in the middle of the river than at its banks. How much higher under given circumstances, I do not know; but the curved surface of the river is very perceptible to the eye on looking across it. Now the question is—Is the pressure of the water on the banks *greater* in consequence of this elevation of the middle of the river, or is the pressure on the banks, in all cases, *due only* to the depth of water that rests immediately upon them?

A solution of the question is not without some practical value, and a difference of opinion is entertained respecting it. Practical and interested observers, who have to maintain embankments upon our Southern rivers, assert that it is greater, at least they say that their embankments always give way on a *rising* river, and that as soon as the river is on a stand, they have no further apprehensions of a break. This might naturally be accounted for. But they further say that the *spout-holes*, so called, or little jets d'eau, that spring up in low grounds inside of an embankment (owing to the water finding its way through some subterranean channel) cease to spout, and run only with a dull current, as soon as the river ceases to rise—thus indicating a diminution of pressure. Of course, the water is supposed to be still, or without current infringing on the banks.

I have made more words than I intended. If you deem the subject worthy attention, you will oblige me and others if you will notice it.

Yours very respectfully,

Chas. Fred. Johnson.

[Questions in some respects similar to the above have been several times propounded to the scientific world, but without receiving, to our knowledge, any satisfactory solution. As an essential preliminary to any inductive reasoning on the subject, definite observations are required—first, with regard to the actual amount of difference in level; and, second, with regard to the relation between this and the rising or falling of the river. Any one favorably situated would confer a favor by forwarding the results of observations on these points, particularly the former. Careful measurement on a rock or island in the middle and at the bank, at different times, might determine with sufficient accuracy.—*Ed. App. Mech. Mag.*]

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[For Appletons' Mechanics' Magazine.]

The Rifle and its Projectiles.

That the three drawings of slugs, given on the 55th page of the present volume, point to "a general solution, embracing *each of the three*," does not seem to me at all probable. That there is, nevertheless, *a* solution seems equally certain.

When, in 1848, Chapman published his admirable work on the improved form of the rifle then introduced by Clark and also by Wesson, he either was not in possession of facts to enable him to determine the most perfect form for the projectile, or did not think it necessary. Now, however, when the performance has been considerably improved, it becomes of importance to ascertain to a nicety the form which will experience the least resistance in its flight, and produce the most accurate and uniform results. We do not hope to solve this problem, but wish to establish some points which may serve to induce others to investigate the subject.

A body projected from a rifle has two motions, viz., a progressive motion and also a revolution around its axis. By means of an instrument lately contrived called the rotoscope, it is strikingly illustrated that a revolving body has a tendency to retain its axis of rotation in the same position, and that as the speed of rotation increases, this tendency becomes very considerable. Here, then, we have the true cause of the superiority of the grooved barrel over the smooth—because it retains the axis of the missile unchanged, and permits us to use a form approaching to that of the solid of least resistance, and not entirely, as was formerly supposed, by balancing the inequalities of density in the lead.

Fig. 1.

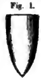
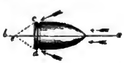


Fig. 2.



This accounts for the fact that, *cæteris paribus*, the shorter the twist the more accurately will the ball move. The form of projectile most widely adopted in the United States is represented in Fig. 1.

The advantages claimed for this slug are that it, being flat behind, receives more of the force of the powder, and that force in a more effective direction; and, secondly, that the vacuum created behind it in its rapid passage through the air helps to steady it.

Let us notice this last point.

Chapman (American Rifle, page 34) says: "The average velocity [of the slug] at forty rods was 1320 feet in a second; the *initial* velocity is probably near 2500 feet per second." Recent experiments I have made with the ballistic pendulum lead me to consider 2611 feet per second a nearer approximation to the truth.

Now, air will rush into a vacuum with a speed of 1296 feet per second; if, then, the projectile moves with a greater velocity than this, a perfect vacuum will be formed behind it. The pressure of the atmosphere is, as is well known, about 15 pounds on a square inch of surface; if, now, the area of the butt end of the slug be assumed equal (as many are) to a sixteenth part of a square inch, there will be a constant force of nearly one pound holding the slug back, if we may so speak. This force which draws the slug back acts as does the shaft of an arrow—to steady the head—and for this reason partly, the slug does not go with its heavy end forward.

Another reason why the slug retains its sharp end foremost is, that its rapid revolution (as high as 504 turns in a second) tends to retain its axis fixed, and consequently to prevent it from turning over.

Fig. 2 represents a form of projectile which has been lately introduced and is thought to be a considerable improvement on the one first mentioned. The one represented in the diagram weighs 88 grains, and is used in a rifle of 150 to the pound calibre; it has a shallow groove around it, near the back end, which is intended to retain the air.

The line *a b* is the axis of the slug; *c e d* represent the form of the partial vacuum in the rear of the slug, when in motion; the arrows are intended to represent the currents of air around the missile when in motion. The air, it will be seen, tends to impinge on the side of the groove, which is nearest the hind end of the slug, and thus aids the effect of the vacuum *c e d*.

A. O. B.

(To be continued.)

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Flame and the Fire Annihilator.

The fact that Phillips' convenient portable apparatus for generating steam and gases in case of fire has become a byword and a reproach to inventors, is but another illustration of the serious importance of grounding the claims of a new invention on facts which will be supported by the practical tests to which it is sure sooner or later to be subjected. Considerable time having elapsed since the failures which drew down upon its ridiculous pretensions the contempt which they so justly merited, the public may be interested to learn that the manufacture and sale is still continued with some success, the sheet-iron workers at the Novelty Works being now engaged in completing the second thousand in fulfilment of the original contract. The apparatus, we learn, has been employed with favorable results in eleven accidental fires, in some of which this was the principal or only cause of its "annihilation." These remarks are due to the much-abused machine, after our allusion to it on page 72, as one of the class which "seem designed to be a speculation on the ignorance of the public." From the extraordinary height to which expectation had been raised, when the gas was entirely "innoxious to life;" when there was to be an end, through its means, of "all extensive conflagrations in America;" when the press of the land, far and wide, vied with each other in the most extravagant praises, and when this journal maintained, almost alone, an adverse opinion,—from this height there is a possibility that the reaction may sink too low, and the apparatus be rejected in situations where it might be of service. Now that the crisis of the fever is safely past, we may be excused for trespassing on the patience of our readers with a brief canvass of its actual merits and demerits, before too summarily ranking it among the things that were.

The Fire Annihilator is a double case of sheet-iron, containing water between the outer and inner casings. The inner case contains ingrediants for producing heat, and also nitrogen and carbonic-acid gas. The ingredients become combined or kindled by fracturing a vial, and form a burning, boiling compound of chlorate of potass, sugar, sulphuric acid (oil of vitriol), charcoal, nitre, and gypsum—the furnace of a miniature steam-boiler. The gases from this mass of liquid fire mingle with the steam which is rapidly generated around it, and the whole forms a great volume which is incapable of supporting either flame or animal life. In order to understand fully its rationale, the theory of flame must be understood. Flame is gas on fire. The jets of gas illuminating our cities, the flame of a candle or lamp, the flame from wood or bituminous coal, are streams of gas, *or fire at the surface.* The centre of a flame is not incandescent, as may be proved by intercepting the flame of a common lamp with a sheet of paper and withdrawing it when sufficiently scorched. If the experiment is skilfully performed, the paper will be brown only in a ring.* The material rises in the wick by capillary attraction, is decomposed into a gas by the heat, and rises in a constant stream. The outside of this stream receives the necessary oxygen from the air, and burns, making a thin shell of fire, which sheds light on surrounding objects and keeps the wick sufficiently heated for its continuous operation. If a sudden puff of the breath blows the stream aside but for a moment, the wick is partially cooled, and the miniature gas-works at once suspend operations. The generation of gas, in fact, continues faintly for a few seconds, but is too much cooled to ignite, except by fresh contact with flame. Analagous to this is the combustion of all the fats and resins, and other substances, where there is no solid fire to maintain the heat in a temporary absence of the flame. The presence of Phillips' steam and noxious gases, surrounding the outside of such a stream, prevents the access of oxygen, or, if vomited into it in sufficient quantities, dilutes it, and destroys, for the moment, its combustible property. In either case, the flame is strangled, until the steam, &c., is in whole or in part carried away, which would often be long enough for its complete extinguishment. Where any coal or solid fire exists, it can be of little service, except as a check on the flame, lasting only so long as the atmospheric air is excluded. Solid fire in various forms is often very tenacious of existence, progressing and destroying to a great extent even in the most pent-up situations. The extraordinary preference manifested by the interested parties for tar, resin, and other highly inflammable materials in the exhibition fires, is thus readily explained, as also the strong preference for buildings constructed expressly for the purpose, of green boards, without plastering or other nooks and crannies in which fire could conceal itself till the blast of steam was past. We were present at the long looked-for experiment in this city in December, 1851, which was managed by the inventor himself, and under the auspices of the American Fire Annihilator Company; and while we deliberately pronounce the whole proceedings, from the advertisement of it as "a trial which should convince the most skeptical," to the subsequent pretence that Mr. Philips was personally endangered by the mob, to be, in our opinion, the most complete and consummate specimen of humbuggery ever attempted to be imposed on the serious business community, we at the same time express it equally our conviction, that the products of this apparatus might be, and are more effective in extinguishing burning spirits, tar, oil, and similar substances, than a supply of water, unless the latter could be obtained in large quantities. The business is now in the hands of other managers, and it is of little moment to comment on the manœuvres at its first importation. The question, and the only one with which we suppose our readers to be concerned at this late day, is its practical value. We consider one or two fire annihilators to be of trifling importance in ordinary cases of fire—of great value, perhaps equal to a pail of water, in case of a fire just starting in a close room—of questionable, but possibly of supreme importance, in the close hold of a ship—(more experiments should be published relating to this point)—and of great effect in subduing fires of any kind which consist of mere flame, as does the burning of tar and turpentine. From the nature of its construction and rarity of its use, we should consider the apparatus one quite liable to be neglected and out of order, especially in being destitute of water when wanted, and somewhat liable to objection from danger by unskilful management, explosion when in use, or spontaneous or accidental operation when not wanted. We were informed that the early trials in London were seriously marred by several accidental explosions, which spread the burning contents to the injury of the bystanders. In reference to another point, we may allude to the report of an alarm on board the English mail-steamer Severn, which has been extensively circulated both in England and in this country, and which proves to rest on quite an insignificant though ominous affair, consisting of the spontaneous or accidental ignition of the materials, while quietly standing in its accustomed place in the cabin, making a great disturbance, blistering the paint in the cabin, &c. This journal was, we think, the first to oppose the claims of this tremendous invention at the outset, but from no lower motives than strict justice, both to the company and the public; and if, in the above few lines, we have conveyed any new facts to our readers, or exhibited older ones in any clearer light, our object is satisfactorily accomplished.

New Publications.

"The Naval and Mail Steamers of the United States." By Charles B. Stuart, Engineer-in-Chief of the United States Navy, author of "The Naval Dry Docks of the United States." C. B. Norton: New York, 1853.

Whether considered with respect to the prominent part which the subjects of this work are made to play in both national and individual policy, or with regard alone to the mechanical execution of the book and the high official position of its author, this volume is one of the most important which has been lately issued from the American press. It is the second of a series on kindred subjects in course of publication on engineering subjects, and is an elegant and substantial quarto of 216 pages, illustrated by 36 large engravings. The novel spectacle presented by the mere existence of a publication with this design may well command attention. In this volume we have not merely under the sanction, but from the very hand of the Engineer-in-Chief of a nation which has already, to a certain degree, assumed the protectorate, and hopes soon to cover with its flag the whole Western continent, a minutely-detailed description of the hulls, machinery, armament, rigging, and performances of every steamer in its navy, and, to a considerable extent, the same information respecting all the mail steamers which may, by the terms of their contracts, be relied on by its government for naval purposes. Perhaps few movements are more indicative of the liberal spirit of the age than thus minutely to display the resources and present them for the patronage and approval of rival nations, as well as our own.

Considering some very extensive alterations and rebuildings of the Fulton, Alleghany, and Princeton, equivalent to the construction of new vessels, and counting them as such, the whole number of steamers, of all classes, which have been constructed or purchased by the Naval Department is 81; of which but 18 now remain in the service, excepting always the experimental steamer Union, now used as a receiving-ship at the Philadelphia Navy Yard. Of this small number, the Susquehannah and Powhattan, 9 guns, are alone ranked as first class; the Mississippi, 10, Saranac, 6, San Jacinto, 6, Princeton, 10, and Alleghany, 10, are of the second class; the Fulton, 5, Massachusetts, —, and Michigan, 1, of the third; and the Water Witch, 3, John Hancock, —, and Vixen, —, of the fourth. These will be included in a concise table which will soon be presented in our pages, showing the dimensions and average performances of nearly all our ocean steamers. The steam navy of the United States proves to be less than that of Spain, Holland, Prussia, or Russia; is only about one-eighth that of France, and one-twelfth that of England. This is without regard to the mail steamers; of which, the Arctic, Baltic, Pacific, and Atlantic, the Ohio, Georgia, and Illinois, are, by contract, "so constructed as to render them convertible, at the least possible cost, into war steamers of the first class;" in addition to which, the Washington and Hermann, the Franklin and Humboldt, on the Atlantic side, and the Golden Gate, Tennessee, Columbia, Panama, California, Oregon, and John L. Stevens, on the Pacific, are conveying the mails under contracts which stipulate that the government have the right to take them for war purposes. In addition to all these, there exists a large fleet of first-class mail and other steamers on the Atlantic and Pacific coasts, not included in the contracts referred to, but which might probably be more or less available on some terms, in case of a sudden outbreak of hostilities with any powerful nation. On the question of the value of such steamers as those of the Collins line for war purposes, a large amount of information is collected from various official sources, the influence of the author being thrown strongly in favor of their availability and usefulness.

But, in any view of this question, our steam navy is quite limited compared with those of the European powers; while, in the language of the author, "we are commercially the second maritime power of the world, with a coast extending for thousands of miles on two oceans; and bear such a relation to foreign nations on this account, as have for a number of years past involved the constant possibility, and oftentimes the serious probability of hostile collision, a remarkable instance of the reliance which is placed by our government on the latent and undeveloped sources of power in our country."

"A reference to the detailed performances of our war steamers, as given in this work, will show very conclusively that, in point of speed, they excel the best steamers of a navy which has spent millions in experiments, and exerted the most strenuous efforts to attain perfection, while it is also true, that in economy, efficiency, beauty of construction, and convenience of arrangement for purposes of war, their superiority is not less decisive.

"What is true of our naval steamers, is also true with regard to our mail steamers. While they have in numbers a corresponding ratio with those of England, they have in all their important qualities of architectural and mechanical construction a similar superiority—a fact which is a source of national pride and gratification, as well as an honor to the private enterprise and skill developed in their construction. It is also worthy of remark that, like the naval steamers, they are by no means superior copies of English hulls and engines, but, in most instances, possess features essentially original."

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* Annexed is a fac-simile of such a "diagram," obtained from the lamp by which we are writing. There are many other methods of proving that flame is hollow, many of which may naturally suggest themselves to the curious. Spirits and burning fluids burn with a more solid flame, in consequence of their containing a large proportion of free oxygen. To this is attributed the great heat of a spirit-lamp. The nature of combustion, both of solids and of gases, is quite fully shown in vol. 2, page 160, "Combustion and Fuel;" and page 200, "Review of Report on Coals."

A voluminous appendix to the work furnishes copious extracts from the steam logs of the various vessels, lists of engineers, both of the naval and mail steamers, full specifications for the construction of the Powhattan and Susquehanna, and also two of the Collins steamers, the letter of Chief Engineer Gay on the value of sails to a paddle-wheel war steamer, the report of the author's experiments on coals, with an additional letter, a description of Pirrson's fresh-water condenser, and a comparison of the logs of the Collins and Cunard lines, with the log of the quick trip of the Arctic from New York to Liverpool, in 9 days, 17 hours, 12 minutes, mean time.

The work is not without faults, of which the most serious is the existence of a few positive errors. As a book for reference, its value would be increased by more distinctly denoting in each case whether the description is of the present vessel or of a superannuated affair long since replaced. Several typographical errors are allowed to appear, points of importance are omitted, which, doubtless, might have been readily supplied, and, in some cases, the descriptions of tha merchant steamers are more or less essentially at fault. Taking the engines of the Golden Gate for example, the framing is somewhat obscurely described as if giving two diagonal braces to each pillow-block, while there is but two to each engine. This is trifling compared with the information that the valves are "arranged with Allen's adjustable cut-off," while there is nothing approaching to a similarity, either in the velve motion or in the method of working or adjusting the cut-off valve. The precise arrangement by which the puppet-valve is adapted to the oscillating engine may be the invention of Mr. Allen, as we believe it is, and designed to be patented, but is essentially different, in every respect, from "Allen's adjustable cut-off," as applied to the Humboldt, Atlantic, and others, and known as *the* Allen cut-off by engineers generally. The text will undoubtedly be revised and the errors expunged before the issue of a second edition which is now in preparation. The work is one which commends itself, both to engineers and gentlemen of leisure, as an elegant and valuable parlor book, and is an interesting history, as well as description, of our infantile steam navy.

The finely-executed drawing of the engines of the Golden Gate accompanying our present number is, with the exception of tha lettering, a transfer from one of the illustrations of this work.

Monthly Notes.

Professor Crestadoro, of some place, has published a plan for propelling vessels by smooth drums, in place of paddle-wheels; in other words, he proposes to case over the periphery of the wheels, instead of inserting paddles. This folly is based on a supposed analogy to the case of a locomotive on a railway.

A paper lately read before the Institute of British Architects, sets forth that, contrary to the opinion of the London Board of Health, *soft* water, instead of *hard*, is injurious to animal life. The position is sustained by numerous facts, showing the low tone of the system, and the glandular affections induced by the absence of lime, in any form, in the water, to be as decided as the excessive development of the sanguine temperament produced by too great a proportion of those substances.

A manufacturer of woollen cloths, near Penistone, England, has discovered that milk mixed in large proportions with olive oil, forms a compound quite superior to the pure oil, of which large quantities are used, at great expense, in that business. A great economy in manufacturing is anticipated, and the discovery has materially advanced the price of milk in the manufacturing districts. Steam has superseded both these articles in some of our best woollen mills.

Claude Arnoux, of Paris, has patented in England the following style of railway carriages: he uses two axles only for each car, and fixes the necks of the axles so that each is capable of shifting, independently of the other. The carriages are guided, not by the action of flanges grinding against tha side of the rail, but by friction-wheels, supported in inclined positions, to run against the side of tha rails.

A marine railway of extraordinary length is proposed, to enable large steamboats with their loads to pass the Falls of the Ohio. The Portland Canal, on the Kentucky sida of the river, carries only vessels of 180 feet or less in length, and 48 feet, extreme breadth, over the guards, excluding nearly all the first-class steamers (see dimensions on page 62). The increasing trade through the Ohio river, accruing from the completion of tha railroad lines through Virginia, Pennsylvania, and New York, has induced the projection of the railway on the Indiana bank, of a width of about 72 feet, and of a length about 1½ mile, with a lock at each terminus. The difference in level, between the head and foot of the falls, is about 24 feet. The carriages on which the boats will be transported are to be moved by stationary engines, by means of a wire rope or chain, the whole adapted to the transporting of steamers 350 feet in length. The lock at the lower terminus, we are informed, is to facilitate adjusting the boat on the cradle, and to diminish tha grade.

The composition of a new plastic material, for forming various objects, has been published in the London Chemical Gazette. It consists of five parts of sifted whiting, worked up into a paste, a small quantity of Venetian turpentine being added to destroy the brittleness. It cools and dries in a few hours, and becomes as hard as stone. A small quantity of linseed oil is added to prevent its clinging to the hands while the Venatian turpentine is being worked into the paste. It may be pressed into shapes, worked by hand into models, or moulds may be made of the same material for reproducing images. The mass must be kept warm during the process. Any desired colors may be kneaded into it.

Mr. Joseph Harrison lately exhibited, at a meeting of the Franklin Institute, two iron cases which had been made the subject of experiment with regard to the strength of stayed plates. The largest plate, 28 inches square, ½ inch thick, with stays ⅞ inch diameter outside of the thread, and 6½ inches apart, withstood an hydraulic pressure of 900 lbs. per square inch. The smaller, 18 inches square, ⅜ inch thick, stays ½ inch diameter outside the thread, and 2¾ inches apart, exhibited very marked appearance of bulging between the stays at 295 lbs. pressure. The experiments were made at St. Petersburg, in 1848.

Theodore Poescher, of Philadelphia, proposes a screw steamer to navigate the air. The ship to be built very light, of a length 20 times the breadth, and provided with small wheels underneath, and large inclined planes at the sides. The ship, on starting, is to run along the ground till the air under the inclined planes raises it like a kite. In the opinion of the propounder, "the greater elasticity of the air will compensate for its want of density," and "where the tonnage is the same, a vessel will not require more power in the air than in tha water." Few will hesitate to decide against the plausibility of this scheme.

An electric, or electro-magnetic, arrangement, for actuating the valves of organs and the hammers of piano-fortes, has been registered in England. The depression of the key completes the circuit, and causes the electro-magnet to attract its armature, which is attached direct to the valve or hammer, dispensing with the usual complicated mechanism.

A sculptor of Paris has patented a composition for superseding gutta percha and caoutchouc, in their different applications. Gutta percha, in a heated or plastic state, is to be mixed with an equal quantity of Roman cement, reduced to a pasty consistence with oxgall. The ingredients must be well kneaded.

Mr. Thomas Allen, of Edinburgh, is stated to have produced an electro-magnetic machine of great power, at small cost. He claims that the former applications of electricity, hava all involved a waste of from 80 to 90 per cent. The details have not been published.

The Engineers' Institute, of the city of New York, have just organized for the ensuing year by the election of the following officers: President, Thomas H. Faron; Vice-Presidents, Geo. P. Clark and E. H. Hanna; Recording Secretary, John Peake; Treasurer, E. Faron; Corresponding Secretary, Dewitt C. Gregier. This institution has been lately incorporated by act of the Legislature. The Institute rooms are at the corner of Broome-street and Bowery. Communications should be addressed to the Corresponding Secretary at the above place.

An organization, with the title of the American Association of Inventors, has been commenced in this city during the past month. The general annual election is to be held in this city in October. The principal officers at present are as follows: Clinton Roosevelt, President; W. Wright and Benj. Sherwood, Vice-Presidents; J. K. Fisher, Recording Secretary; Warren Rowell, Treasurer; and H. D. Sheppard, Corresponding Secretary.

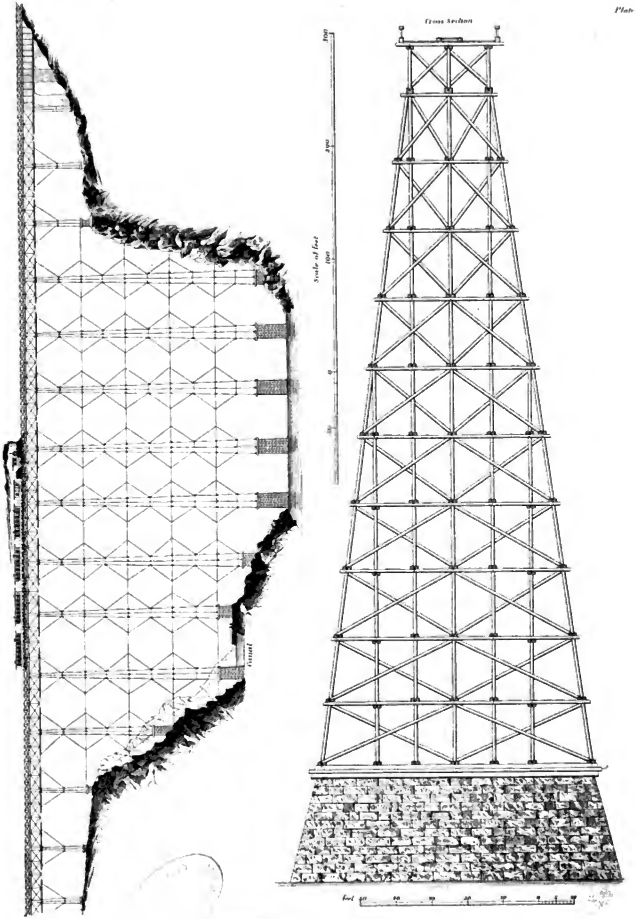
A telegrapher named W. D. Wesson, at Chilicothe, O., is advertising for a partner with capital, to experiment on the practicability of establishing communication between stationary offices and railroad trains in motion.

Somebody calling himself a "Maine Yankee," claims to possess a plan by which railroad trains may travel one hundred miles per hour, in consequence of a new form of road and improved locomotive. The boiler is to generate steam faster than at present, and both locomotive and cars are to be relieved from vibration. This is as far as the plan is yet revealed.

The finishing of the Crystal Palace in this city is likely to be delayed far beyond the advertised time. Unforeseen difficulties are said to have been experienced in the construction of the dome, in consequence of which the building will not probably be ready for exhibition until the last of May or first of June. We have it semi-officially that great efforts are being mada to complete the whole so as to open some time in May, and that portions of the building will be ready for the reception and safe-keeping of goods, certainly by the first of May. This postponement will be a disappointment to some; but there are others no doubt, who, like the managers, allowed themselves too little time, and will gladly avail themselves of this opportunity to complete their articles for exhibition. We know several who are in that position. Valuable machines, &c., will, we think, be received for several weeks or months after opening. Intending exhibitors will please take particular notice.

☞ Notices to correspondents, &c., are crowded out,—will appear in next.

HIGH BRIDGE, PORTAGE, N.Y.



Engraved for Appleton's Mechanics Magazine by W. C. Barnard

APPLETONS'
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SPEED OF THE TRANSATLANTIC STEAMSHIPS, DURING THE YEAR 1852.*

BY B. F. ISHERWOOD, CHIEF ENG. U. S. NAVY.

Finding it necessary for my own information to know the fair average performances of the Atlantic steamships for the last year, I constructed the following tables, in which the "longest," "the shortest," and the "mean passage" are given, with the speed per hour in geographical miles of 6082⅔ feet, at which the mean passage was made. The time of making the passage is the *true* time, not the apparent; 4 hours and 45 minutes being allowed as the difference between the American and British ports. The speed of the vessels per hour is calculated for the following distances, viz.:

New York (battery) to Liverpool,	3084 geo. miles.
Boston to Liverpool, *via* Halifax,	2883 "
New York to Cowes,	3120 "
New York to Glasgow,	3000 "
Philadelphia to Liverpool,	3250 "

In remarking the speeds of the screw vessels plying between Liverpool and Philadelphia, it must be borne in mind, that the time given, and from which the speed is computed, is from dock to dock; and that the latter city being situated on the Delaware River, 110 miles from the ocean capes, obstructions are frequent in its navigation, from fogs, ice, narrowness of the channel, &c., causing occasional detentions, which being included in the time given, make the vessel's speed appear somewhat less than the truth. The steamers plying to New York and Boston suffer detentions from these causes in a less degree.

Table of Passages made by the Boston branch of the Cunard line of Steamships, for the eleven months commencing Jan. 1st, 1852, and ending Nov. 30th, 1852.

Names of Vessels.	From Boston to Liverpool.					From Liverpool to Boston.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
Canada,	7	18 4 15	10 11 45	11 6 28	10·6628	6	12 23 30	10 10 15	11 6 7	10·6730
Cambria,	8	18 8 15	11 8 15	11 22 55	10·0477	2	15 14 18	12 7 15	13 23 00	8·6069
America,	7	12 12 45	10 18 15	11 13 2	10·4008	8	15 22 30	10 19 15	12 7 8	9·7712
Europa,	1	11 6 45	11 6 45	11 6 45	10·6462	1	15 2 15	15 2 15	15 2 15	7·9641
Niagara,	6	18 15 45	10 17 00	12 1 40	9·9528	6	14 2 00	11 22 25	12 11 42	9·6196
Means,				11 15 14	10·3248				12 8 9	9·7850

Table of the Passages made by the New York and Liverpool Steamships for the eleven months commencing Jan 1st, 1852, and ending Nov. 30th, 1852.

COLLINS LINE.

Names of Vessels.	From New York to Liverpool.					From Liverpool to New York.				
	No. of passages.	Longest passage	Shortest passage.	Mean passage	Speed of the mean passage in geo. miles p'r hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.
		d. h. m.	d. h. m	d. h. m			d. h. m.	d. h. m.	d. h. m.	
Pacific,	7	18 15 45	10 19 45	11 14 41	11·0048	6	14 21 30	9 21 15	11 10 22	11·2899
Atlantic,	6	12 6 35	10 10 45	10 23 17	11·7198	5	14 13 15	10 0 30	11 5 33	11·4418
Arctic,	6	11 11 15	10 3 00	10 22 [illegible]	11·7667	7	13 14 30	10 1 15	11 5 19	11·4511
Baltic,	4	12 23 45	10 14 15	11 10 02	11·2198	4	11 14 15	10 10 45	11 1 21	11·0234
Means,				11 5 40	11·4362				11 6 14	11·4123

CUNARD'S LINE.

Names of Vessels.	From New York to Liverpool.					From Liverpool to New York.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.	No. of passages.	Longest passage.	Shortest passage	Mean passage.	Speed of the mean passage in geo. miles p'r hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
Asia,	7	11 2 45	10 9 55	11 8 51	11·3029	8	12 20 45	10 14 45	11 14 37	11·0688
Africa,	8	12 15 35	10 14 45	11 5 19	11·4511	7	13 15 15	10 7 15	11 13 58	11.0990
Means,				11 6 58	11·3813				11 14 16	11·0828
Niagara,	1	12 0 15	12 0 15	12 0 15	10·6990					
Canada,	1	11 22 00	11 22 00	11 22 00	10·7382	1	17 16 30	17 16 30	17 16 30	7·2666
Europa,	7	12 15 45	11 1 00	11 19 30	10·8745	7	12 15 15	10 22 45	11 20 45	10·8305
Means,				11 20 23	10·8446				12 14 13	10·2044

As the *Asia* and *Africa* are the only two vessels of the Cunard line, that for size and power can be put in competition with the Collins steamers, it is proper to confine any comparison to them alone—and from the above table it appears, that the mean passage of the Collins steamers from New York to Liverpool was only 1 hour and 18 minutes *shorter* than the mean passage of the Cunard line. The mean passage of the Collins steamers from Liverpool to New York was 8 hours and 2 minutes *shorter* than the mean passage of the Cunard line. It thus appears that in both directions the Collins steamers have made the greatest speed, but in so very slight a degree over their competitors as to be scarcely entitled to the name of victory. Indeed, the mean of the passages from New York to Liverpool may be considered identical when the great distance traversed is taken into consideration; and the difference of 8 hours 2 minutes required by the Cunard line to make the passage from Liverpool to New York, in which head winds and seas are encountered in a greater proportion than in the other direction, may be ascribed to the greater resistance offered by their fuller bows above water, and the greater quantity of their spars and rigging. It is well known that the average consumption of coal by the vessels of both lines per voyage is about 900 tons; the paddle-wheels are substantially the same, and the losses of effect from them about equal. The steam is used, however, in the Collins vessels at a higher rate of expansion than in the Cunarders, but the mean effective pressure in both is about the same. We are not therefore entitled to ascribe any decided superiority to either in wheels, engines, boilers, or model, but in the kind of rig, and in keeping the bow lines sharp high above water, so as to diminish the resistance of the vessel when struck by head seas. The arrangement of the Collins vessels seems to be the most judicious.

The three vessels, *Niagara*, *Canada*, and *Europa* (comprising, with the *Asia* and *Africa*, the New York branch of the Cunard line), though of much inferior size and power to the Collins steamers, have nevertheless maintained a high rate of speed; the mean of their passages from New York to Liverpool being only 14 hours and 43 minutes longer than the mean of the Collins passages in the same direction. The one westerly passage made by the *Niagara*, in which she broke down and put into Halifax, has been omitted; and if we omit also the exceptional single passage of the *Canada*, and confine ourselves to the mean of the *Europa's* passages from Liverpool to New York, we shall find it but 14 hours and 31 mintnes longer than the mean of the corresponding Collins passages.

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* From the Journal of the Franklin Institute.

Table of the Passages made by the New York and Havre, and by the New York and Bremen Steamships, between New York and Cowes, for the eleven months commencing Jan 1st, 1852, and ending Nov. 30th, 1852.

NEW YORK AND HAVRE LINE.

Names of Vessels.	From New York to Cowes.					From Cowes to New York.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
Franklin,	5	13 4 45	10 17 45	11 18 31	11·0806	4	12 7 45	10 8 15	11 12 30	11·2840
Humboldt,	5	16 0 15	11 11 30	13 9 12	9·7136	4	13 1 15	11 4 45	12 2 00	10·7556
NEW YORK AND BREMEN LINE.										
Washing'n	6	22 4 45	13 4 45	15 10 55	8·4115	5	15 8 15	13 12 15	14 8 45	9·0600
Hermann,	4	18 15 55	12 6 45	13 1 44	9·9449	4	13 4 45	11 10 25	12 8 55	10·6151

Table of the Passages made by the New York and Glasgow Screw Steamship Glasgow, *plying between New York and Glasgow, for the eleven months commencing Jan. 1st, 1852, and ending Nov. 30th, 1852.*

Names of Vessels.	From New York to Glasgow.					From Glasgow to New York.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
Glasgow,	6	15 16 5	12 21 45	14 18 5	8·7099	5	14 22 15	12 12 15	14 4 50	9·0446

Table of the Passages made by the Philadelphia and Liverpool Screw Steamships, for the eleven months commencing Jan. 1st, 1852, and ending Nov. 30th, 1852.

Names of Vessels.	From Philadelphia to Liverpool.					From Liverpool to Philadelphia.				
	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.	No. of passages.	Longest passage.	Shortest passage.	Mean passage.	Speed of the mean passage in geo. miles p'r hour.
		d. h. m.	d. h. m.	d. h. m.			d. h. m.	d. h. m.	d. h. m.	
City of Gl.	7	18 19 45	15 10 15	16 8 36	7·1942	6	23 20 45	18 18 25	16 21 2	8·0287
City of M'r,	6	18 4 15	13 3 45	15 23 49	8·4783	5	17 11 21	13 12 15	15 6 44	8·8621

It has generally been supposed that the *very weak* point of the screw propeller, compared with the paddle-wheel, was its inability to proportionally maintain the speed of the vessel against head winds and seas; in other words, that the difference between the speeds of the screw vessel in going with the wind and against the wind, was very much greater than the difference between the speeds of the paddle-wheel vessel in the same circumstances. Now, it is known that for the greater part of the year, westerly winds and seas prevail; therefore, the foregoing tables should show in a marked manner this characteristic of the screw, if it exist. No such difference, however, can be observed; on the contrary, taking the three screw steamships *Glasgow*, *City of Glasgow*, and *City of Manchester*, the mean of the westerly passages of the first is actually 13 hours and 6 minutes *shorter* than the mean of the easterly passages. This, of course, throws out the exceptional passage of February, when the *Glasgow* was obliged to put into Halifax, and was 22 days making the voyage: but even including this passage, the mean westerly voyage is but 13 hours and 47 minutes *longer* than the mean easterly one. The mean westerly passage of the second, the *City of Glasgow*, is only 12 hours and 26 minutes *longer* than the mean easterly passage; while the mean westerly passage of the third, the *City of Manchester*, is 17 hours and 5 minutes *shorter* that the mean easterly passage. From the foregoing tables, then, it appears that no greater difference exists between the speed of these screw vessels going with and against the weather, than between the speeds of the paddle-wheel vessels under the same circumstances. That strong westerly winds prevail for the greater part of the year between our Atlantic ports and the British islands, is proven by the fact that the sailing packets are from one and a half to twice as long making the westerly as the easterly passage.

Table showing the mean speeds of the Atlantic Steamships for the Easterly and for the Westerly Passages; and also the mean speed of the Easterly and Westerly Passages; for the eleven months commencing Jan. 1st, 1852, and ending Nov. 30th, 1852.

PADDLE-WHEEL STEAMERS.

Names of vessels.	Easterly passages; mean speed in geographic miles per hour.	Westerly passages; mean speed in geographic miles per hour.	Mean speed of the easterly and westerly passages in geo. miles per h'r.	Names of vessels.	Easterly passages; mean speed in geographic miles per hour.	Westerly passages; mean speed in geographic miles per hour.	Mean speed of the easterly and westerly passages in geo. miles per h'r.
Canada,	10·6778	10·1864	10·4480	Pacific,	11·6048	11·2399	11·4364
Cambria,	10·6477	8·8060	9·4710	Atlantic,	11·7138	11·4413	11·5899
America,	10·4068	9·7712	10·0678	Arctic,	11·7687	11·4511	11·5077
Europa,	10·8402	10·4722	10·6502	Baltic,	11·2108	11·6224	11·4211
Niagara,	10·0694	9·6196	9·8564	Franklin,	11·0806	11·2840	11·1492
Asia,	11·3029	11·0688	11·1780	Humboldt,	9·7136	10·7556	10·1780
Africa,	11·4514	11·0980	11·2868	Washington,	8·4115	9·0600	8·7017
				Hermann,	9·9449	10·6151	10·2800
SCREW STEAMERS.							
Glasgow,	8·7099	9·0446	8·8621	C'y of Glasgow,	7·1942	8·0287	7·6770
				" Manchester,	8·4783	8·8621	8·6528

[From the Canadian Journal.]

High Bridge, Portage, N. Y.

(See plate.)

The Buffalo and New York and City Railroad is one of the branch roads which have sprung from the New York and Erie road, and is the more especially interesting to us as bringing the six-feet gage to our frontier, and which will at an early date be continued to the mouth of the Niagara River, when it will form one of the many routes of travel which will connect advantageously with the lines of road now being built in Canada. At Portage, the fruitful valley of the Genesee, famed at other points for its gentle slopes and teeming farms, is contracted to a deep and narrow gorge, through which the river dashes over three successive falls of about 350 feet, between almost perpendicular banks of rock, piled in horizontal strata, of from 10 to 30 feet in thickness, to a height immediately below the middle fall of about 800 feet. Thirty yards above the upper fall, at a point where the banks are 800 feet asunder, the railroad crosses at a height of 234 feet above the bed of the river—viewed from the foot of the fall, which adds 100 feet to the height of the structure, a passing train, relieved against a clear sky, has a wonderful and beautiful appearance—while the view from the train, embracing as it does a large portion of Wyoming, is one of surpassing grandeur.

The bridge was designed by Mr. Silas Seymour, the chief engineer to the company, and the successful economy with which he has succeeded in overcoming the difficulties opposed to him, is entitled to great praise, especially when we take into account the short space of time in which the works were completed. The general design of the bridge will be understood from the engraving. The piers on which the "trestles" rest are of the best ashlar masonry, of compact sandstone obtained from the banks of the river; their base 75 by 15 feet; they are carried up with a slight batter to a height of 30 feet above the bed of the river, and coped with heavy limestone blocks. Upon these are placed the timber trestles, connected with each other in a very secure manner, by a system of braces and girders. The trestles are 190 feet in height, from the top of the piers. At their base they are composed of twenty-one verticle posts, 14 by 14 inches, diminished in number to fifteen at the top; and in size to 12 by 12 inches. The lateral and longitudinal braces, and also the girders, are 6 by 12 inches. Each trestle or pier is calculated to be capable of sustaining a weight of one thousand tons, in addition to its own. The trusses resting on the top, and connecting the several trestles or piers (which are 50 feet from centre to centre), are 14 feet in depth, and are composed of three framed girders with main counter and sway braces, in the usual manner. On the top of these trusses the track is laid. The whole length of the bridge is 800 feet, and each span, with the exception of that across the channel, which is 54 feet, is 50 feet. The arrangement of the structure is such that, when any particular piece becomes defective, it can be taken out and replaced without disturbing other parts of the bridge. The occurrence of fire is, therefore, the chief danger to which it is liable, and against such a calamity every precaution is taken. Tanks of water are placed at convenient distances, and watchmen are employed day and night.

The total cost of the bridge was about 35,000*l.* currency, and the quantity of material employed in its construction is as follows: Masonry, 9200 cubic yards; timber, 135,500 cubic feet; wrought-iron, 49 tons. It was estimated that the cost of a stone viaduct would have been about 250,000*l.*, the interest of which at 7 per cent., would renew the present structure every two years. It was also estimated that the interest on the cost of a wrought-iron tubular bridge, of 500 feet span, with stone piers and suitable approaches, would renew the present bridge every third year. The masonry was commenced on the 1st of July, 1851, and the first locomotive passed over it on the 14th of August, 1852, embracing a period of only thirteen and a half months, a rapidity of construction which speaks volumes for the energy and zeal of the contractors, Messrs. Lauman, Rockafellow, and Moor, who were also the contractors for the whole line of the road, and have long been connected with public works.

The manner in which the piers or trestles were erected may be worthy of notice. They were commenced on the eastern bank, and as each trestle was completed the trusses were placed on them, and the track laid; upon which a travelling crane was advanced, overreaching the space to the next trestle, and by means of which each stick of timber was let down to its place, until the whole of the next pier was completed, when the truss was placed and the crane advanced as before.

This is, we believe, the highest timber bridge in the world; and though not notable for the development of any new principle of construction, it is worthy of our notice, for the cheapness, the quickness, and the completeness with which it has obviated a serious obstacle in the way of an important line of railroad,—all matters of first-rate importance to us at this moment.

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[From the Civil Engineer and Architect's Journal.]

The Patent Laws (English).

The new patent laws are now in operation, and the result is, as anticipated, a great relief to the pockets of inventors, and a great increase in the number of patents, attended with many inconveniences in the working out of fresh regulations. The old fees for a patent were prohibitory to very large classes, particularly of practical men, and were a heavy tax on the means of others. It is preposterous to suppose that a journeyman blacksmith or carpenter can afford to pay 300*l.* or 400*l.* for a patent; and as genius is not regulated by the income-tax, the working man was in most cases deprived of security for his inventions, or could only obtain it in exceptional cases. George Stephenson had no patent for his safety-lamp, and was obliged to obtain assistance to enable him to get a patent for his locomotive. The wealthier classes were fleeced under the old system, by taking out patents which never proved remunerative, or which being superseded by the improvements of the inventor himself, required the outlay for another patent. Thus, Messrs. Cooke and Wheatstone, and Messrs. Highton, have been heavily mulcted for their electric telegraph inventions, having taken out patent after patent, some of which have never been worked. Some, rather than encounter the expense of patents for improvements, have gone on working defective apparatus, for which they could have substituted improved machinery. Until the Registration Act, there was no protection for articles of which the consumption was too small to pay the expense of the patent; and it is to be observed, that some still remain unprotected, although an impression prevails that any thing can be registered, and obtain, for a limited period, the protection of a patent under the Registration of Designs Act.

Certainly a great relief has been obtained in the reduction of the cost of patents; but in many cases it is only the making the first step easy in a most difficult career. To many, a patent will prove a "facilis decensus Averni,"—a short cut to litigation and the Court of Chancery, involving themselves and many of the public. A patentee cannot effectually know whether some one else has not wholly or partially preceded him in his invention, and the public, in manufacturing an article, can never be assured they are not infringing a patent. Therefore, we naturally expect the lawyers have, in the New Patent Act, obtained a compensation or equivalent for what they may have lost by county courts, the abridgment of fictitious pleas, and the temporary abatement of quibbling. With the prospective increase of patents there will be, from the causes we have assigned, a very great increase of business for the equity and common law courts; and patent causes, as they are numerous for each case, and carried on against many parties, and in various courts—in Chancery, in the Queen's Bench, the Court of Session, the House of Lords, and the Privy Council—afford aggregate bills of costs comparable to Railway bills, as witness the litigation on the patents of Neilson, Crane, and Heath, in which the inventors had to contend with all the obstacles which the wisdom of the legislature and the judges has provided.

If an invention be really valuable and useful, it is a great benefit to the public, and its author is a great benefactor, whom it is the duty of the commonwealth to reward. So far from that being the case, the routine has been, first to mulct a man heavily for a title to that which may never pay—not to tax him on his profits, but for the permission to benefit the community; next, to give every facility to those who will benefit by the invention to rob him of his royalties—as witness Watt, and the cases we have just cited, and the personal experience of many of our readers who are patentees. In the case of Heath, his life was shortened by the litigation, to which he was exposed; and it was only on his death that justice so long delayed, was done to his family. It is a great defect, in fact, that there is no national provision to reward inventors. For them there is no pecuniary grant, no pension list, no honorary distinction. In this country, the case of a national benefactor like Robert Mushet, who, by his discovery of the black-band ironstone, has given employment to thousands—the case of such a man excites no remark. George Stephenson is just dead, who received honours from every country of Europe except his own; and Hind, who in the last year alone discovered four planets, has only just received a pension. In this country the reward of the patentee is a lottery; his too common lot is litigation, neglect, obscurity, and impoverishment. A patent fund is, however, now created, under Treasury supervision, and a portion of that might be employed for the benefit of patentees.

With regard to the protection of patentees from each other's claims, it is the duty of the government that receives money for the protection of a patentee to see that he receives that protection; and it is not impossible to provide a remedy in the majority of cases. Let due publicity be given to the notice of application for a patent, and to the specification, and let it be open to former patentees, to oppose within a given time; after which the new patentee shall, if there be no opposition, have a good title; and if he be opposed, the opposition can be decided on by a competent authority. Patentees who are working a patent keep a sharp look out for new ones, but are induced to lie by till a new patent is got into working, and then attempt to crush it by litigation. Such has been the case more particularly with the electric telegraph patents. A great hardship, however, arises from old unworked patents, which are used as an engine for defeating new patents, which by chance include some portion of the specified matter. A competent court could very well deal with such cases in the first instance, and prevent much after-litigation. We cannot, however, see that it is quite so easy to protect those of the public who, as manufacturers, are liable to be interfered with for infringing patents of which they never heard. There should be, we think, some opportunity within a given time, for parties interested in a trade to object to a specification, and this would be a bar to litigation. The patentee might further, unless he was in a position to prove conspiracy, be forced to serve notice on a manufacturer to discontinue working, before he should be allowed to move for an injunction, or to take any legal steps for infringement. It is likewise desirable there should be some cheap jurisdiction for cases of infringement, both for the sake of the patentee and the public.

What is found as a great practical grievance under the new regulations is, that an inventor may be deprived for five or six months of the use of his protection, by some one else having applied for a patent on the same subject just previously, and which, though it may not interfere with the new invention, still as the nature of it is not known until specified, there is no security in promoting the new invention, or making it known. The remedy for this is simple, and will readily suggest itself to the authorities. As it now stands, any one applying for a patent for an improvement in the steam-engine, which may be for cylinders, may impede every other patent for boilers, valves, gages, or any thing which is used in steam and other engines. By the present regulations, a party applying for a patent, and who has obtained a certificate of protection, can delay putting in a complete specification for six months. Although he has deposited a preliminary specification, it cannot be investigated until the complete specification has been filed; consequently, any one coming after him cannot tell whether he has hit upon the same invention as his predecessor or not, and he has to run all risks in completing his patent, excepting his specification; thus it may turn out, upon his predecessor depositing a complete specification, that it is identical with his own invention.

Now, in order to avoid this evil, we cannot see why, in the first "Gazette" containing the notice of certificate of protection having been granted, it should not also be stated that opposition must be entered within twenty-one days from that day; and if no opposition be then entered, the preliminary specification should be open to the public, and no kind of opposition be allowed either before the Commissioners of the Patent Office or the Lord Chancellor; and from that day the patent should be considered as safe, and from that day be dated. The remainder of the fees should be paid and the specification filed within the six months from the termination of the twenty-one days' notice, but if opposition has been entered, then within six months after the day of hearing, and that hearing should take place within ten days after the expiration of the twenty-one days' notice in the "Gazette." By this arrangement any subsequent inventor will be able in three weeks from the date of his predecessor's certificate, to discover whether he can proceed with his patent in safety, and need only run the risk of paying the first fee of 5*l.*; and at the same time this arrangement will not infringe on the time allowed for completing the first inventor's specification. As it now stands, the bulk of the patents are subjected to a process of delay, for it affects all those applying to great classes of machinery, as steam-engines, or new and extending inventions, as electric telegraphs for instance.

Another grievance to patentees, and which is unexpected, is a new regulation suggested by the Downing-street authorities, excluding the colonies from patents. Thus the very inventions which are meant to be used in the colonies, and to have their chief sale there, cannot be patented except by separate acts of each colonial legislature which may be graciously pleased to concede it. Patents relating to sugar, cotton, coffee, and gold-washing, for example, may be considered as abolished; and patents for wool-cleaning, tallow-boiling, jute, New Zealand flax, and other articles, will be in many cases rendered unproductive, and invention discouraged, to the great injury of the colonies. An efficient mode of preparing phormium tenax would be the greatest boon to New Zealand, and which the colony would be willing to reward; but the home inventor is at once discouraged when debarred from the protection of a patent. As to sugar processes and apparatus, to obtain protection it will be found necessary to get acts from about fifty legislatures, ranging from our Indian empire to the petty commonwealth of Montserrat, and therefore out of the question. On the lowest estimate these acts would cost 10,000*l.*, and this as a beginning. The restrictive regulation is one of the new-fangled contrivances of Downing-street, under which we have to pay all the expenses of the general government for the colonies, hand over to them the public lands, customs duties, and post-office revenues, and receive nothing in return. Latterly, the colonies have taken to the piracy of books and maps, and now the patentees are to be surrendered to the tender mercies of the colonists; so that we may soon see a patent article advertised to be sold at Sydney, with the latest improvements of its inventor, and for which he will not get one farthing. If, too, the new-fledged legislatures condescend to grant a patent, it may be that, like our Yankee brethren, from jealousy of our inventors, they may charge us with a heavy differential rate, as they tax our other productions. We need scarcely say that no such absurdities prevail under the constitution of the United States, but that a mechanic in New York or Maine may, for a few dollars, get a patent for gold machines which the State of California alone may use. There, on the announcement of the gold discoveries, the genius of New England and the Middle States was at once put into requisition, and a number of valuable machines have been invented to meet the requirements of the Californians, who never thought of complaining of monopoly or breach of privilege.

A deficiency which was felt in the old law, and is not met in the new, is a cheap process for engrafting improvements in patents. It is a great hardship that all the original expense must be incurred for improvements which supersede and nullify an original patent for which the government is paid, though the inventor ceases to derive benefit. It is true he may discontinue, and save so far, and he may take out a new patent for the improvements; but it would be better in the interest of the public if he could amend his old patent for the original term, leaving the question of any extension of time to the subject of an application in the usual form and period to the Privy Council.

Now that there is a prospect of getting a considerable revenue from patents, and that the department is under a new organization, we trust the government will take the necessary steps to make out what has been so long wanted—an accessible register of specifications, and a complete index. Unless Dr. Panizzi, the catalogue-delayer of the British Museum, be employed, there can be no insuperable obstacle to the completion of this in a moderate time. A preliminary index may be speedily compiled; the "Post-Office Directory" staff index 120,000 names, addresses, and occupations every year, and that is more than the first patent index would require. It may be added, they print their information in a cheap and accessible form.

One great want which the lawyers have made the patentees feel, is a cheap and equitable tribunal, not of lawyers who know nothing of the subject discussed and can never understand it, but of practical men, in the nature of the Tribunals of Commerce to be found in every civilized country but this, and even in the most lawyer-ridden. Perhaps, however, something like the Conseils de Prud-hommes of France would be more suitable for patent cases. We want local courts, cheap courts, and practical judges. What, indeed, can be more ridiculous or more mischievous, in an industrial country like this, than for a patent cause to be taken from Birmingham and carried to a body of lawyers in the Common Pleas or Vice Chancellor's Court. The masters and journeymen of Birmingham, and of each manufacturing district, could as well choose every year judges from among themselves, as those of Rouen or Lille do. Before such practical men the proceedings would be equitable, cheep, and speedy.

With the new patent regulations a fresh era is opening for inventors, and, unless care be taken, an era of disappointment and litigation rather than of profit. The regulations require amendment in many points, and this can only be effected by the pressure from without. Thus, the grievance as to colonial protection must be battled with the several ministerial departments; individual patentees cannot do this, or cannot do it effectually, and therefore they must combine, or they will not obtain redress. In patents, there is a large amount of capital at stake, and a large interest has been created which is not adequately represented, or rather it may be said is not at all represented. We therefore strongly urge the association of patentees for their mutual protection.

Although we have gone into the subject at some length on the present occasion, we have only touched on some of the inconveniences which are already experienced, and we shall take other opportunities of calling the attention of our readers to it.

[From the Journal of the Franklin Institute.]

Application of Steam to Ships of War.

BY WILLIAM N. JEFFERS, U. S. NAVY.

THE evident superiority which a steamer possesses over sailing vessels, in the navigation of the rivers and along the coasts, and, within late years, the success of extended voyages by steamships, has very naturally suggested the more extended application of steam to ships of war. The advantages of rapidity and certainty of transit, her independence of fickle winds and adverse tides, are so striking, that even the least conversant in naval affairs esteems himself competent to decide the question, and joins in the cry which denounces as "old fogyism," the expression of a doubt as to the ultimate advantages to be derived from the substitution of steam for its more economical rival. To the present time, this asserted superiority has not been proved to exist, and it is very doubtful whether the efficiency of the navy, far less that of an individual ship, has been increased by the means already adopted. I have been led to make these remarks, by reading in an article in the July number of this *Journal*, from the pen of a distinguished authority (W. Fairbairn), the following: "Steamers can back out of difficulties and dangers, when sailing vessels must remain exposed; they can assail the enemy at a great distance, and take up any position they choose; and with their great guns and long range, inflict severe punishment, and do great execution, without receiving a single shot."

We have here in five lines five assumptions, at least four of which we think erroneous, and shall proceed to state the grounds for our opinion. We do not pretend to deny any advantages which may be claimed for the steamer in a littoral warfare; but for that purpose celerity of motion, light draft of water, and capacity for the accommodation of large bodies of troops, are indispensable. Such enterprises are not successful by reason of any force in the steamers, but in their unexpected presence in front of the enemy, or success in clearing natural or artificial obstacles, supposed sufficient to bar their progress. That this view of the case is a correct one, is shown by our own operations in the Gulf during the war with Mexico, and the warfare of the English in China. The vessels employed on these occasions were in no respect capable of sustaining an action with sailing ships of war, and owed their success to the weakness and unprepared state of the enemy; they were common steamboats, purchased for the occasion, and for similar occasions always to be procured at a day's notice.

But the principal duties of a navy are upon the open sea; engaged in convoying our own merchant ships; the capture of the fleets of the enemy; the destruction of his commerce; cutting off his supplies; capture of colonial dependencies; the transportation of large bodies of troops from point to point, and the blockade of his harbors. These are the duties of the navy. But if called upon to man floating batteries, and to defend harbors which may be better protected at less cost by permanent fortifications, or to land in large bodies, and effect permanent lodgments on the enemy's territory, good seamen are at an enormous cost turned into indifferent soldiers. To perform these specific duties, suitable ships in sufficient numbers must be provided. What are suitable ships?

A man of war, to be efficient, must be able to keep the sea for a considerable period, certainly four months; otherwise, her frequent entrance into port for supplies, would give the enemy all the information he desired as to the force, destination, and cruising ground of the fleet or ships. None but the smallest sailing vessels are forced into port oftener than once in four months, while the larger ships may keep the sea six months. Steamers of full power, that is, those capable of making ten knots and upwards under steam alone, are unable to carry more than fifteen days' fuel, which may be made to last with very moderate speed double that period, or thirty days, and without fuel they are comparatively helpless; consequently, when the scene of the intended operations is distant, the sailing ship can reach the rendezvous in as short a time as the steamer. The greatest distance yet passed over under steam was about 4000 miles, at an average rate a little less than eight miles an hour; while the passage of the *Flying Cloud* to San Francisco exceeded the rate of eight miles and a half an hour, and was but three or four days longer than those of the *Golden Gate* and *Winfield Scott*, two crack steamers, which were forced to make three ports by the way. The propeller steamship *S. S. Lewis* reached San Francisco in 124 days, beaten by nine-tenths of the California fleet.

It may be objected to this comparison, that our men of war do not equal the *Flying Cloud* in speed; nor are the steamships in this respect equal to the *Golden Gate*. The speed of our men of war is not, however, to be judged of by their passages, for we have no object in forcing our ships, and under ordinary circumstances in time of peace, no officer is justified in risking the smallest spar; the object of the cruise is accomplished by the presence of the ship on the station. Nevertheless, the passages of some of our ships have never been equalled by the finest of the clipper fleet. We are of opinion, therefore, that it is not proven that the steamer possesses any great advantages in making a passage, except under peculiar circumstances of constantly adverse winds and currents, when the distance is greater than the steamer is enabled to make without calling at a port or ports by the way.

Hitherto we have considered the relative capabilities of the two ships for keeping the sea or making a passage, but it must be evident that this is one of the least of the conditions to be fulfilled. The extent of a navy being governed by the ability of the nation to sustain the cost of construction and maintenance, the steamship ought to be of at least equal military force with her sailing rival of the same cost; else, on her arrival at her destination, she will be forced to accommodate herself entirely to the movements of the enemy. On this point, the relative force of the two ships, the most erroneous notions prevail. One gun mounted upon a steamer is assumed to be equal to the battery of a ship of the line. This notion is, however, but the reproduction of a long since exploded system; that of a navy of gun-boats, for steamships are but gun-boats moved by steam instead of sweeps. "In calms, gun-boats are the sovereigns of ships of the line," says an able writer; and from naval histories he gives terrible examples to prove the truth of his assertion. The system no longer has an advocate, and experience has proved that individual examples to the contrary do not invalidate the general rule that superior force must ultimately triumph.

The great fallacy upon which the enthusiast and the ignorant base their argument in support of this opinion is, that steamers are able to assume at will any position, in spite of the efforts of the sailing ship. They begin with the assumption, that a dead calm prevails, and their adversary floats motionless on a glassy sea, "like a painted ship upon a painted ocean," helpless. This assumption cannot be granted, for an examination of the logs of many ships shows that calms are by no means common; in fact, that, except in the close proximity to land, and in certain latitudes easily avoided when lying in wait for an enemy, it is very uncommon for a ship not to have steerage way. We will, however, admit, that it is during a calm that a well-appointed steamer falls in with an equally well prepared frigate. The effective range of the eight and ten inch-shell guns, with which steamers are armed, is about 1200 yards, and of course, with her very small number of guns and ability to choose distance, it is her advantage to maintain the distance which makes her gunnery most effective. At this, as well as at any other distance, the eight-inch shell guns of the frigate are at least as effective as those of the steamer, while the whole battery of 32's will tell with solid shot; consequently, the steamer must avoid the frigate's broadside; but to pass over a quarter of a circle to get from the broad-side to the stern or bow of the sailing ship, she must pass over a distance of 2000 yards, which at eight miles the hour, takes eight minutes. Now, will any seaman believe that the direction of the ship's head cannot be altered eight points in as many minutes? The two quarter boats, with a line from the end of the jib-boom, will tow her round; or parachute drags may be laid out abeam (with a similar machine the late Com. Porter propelled the *Essex* three miles an hour); or an athwartship propeller, as proposed by R. L. Stevens, Esq., and a similar one experimented on in England, worked by hand or a small engine of ten horse-power. Other methods will doubtless suggest themselves; so that, in our opinion, this idea of choosing position is altogether delusive. If the steamer closes to a less distance, she comes within range of a broadside of 6¼ inch shells, which, though not quite equal to the 8 inch, are yet quite sufficient for the purpose, and the steamer fights at the terrible odds of six guns to fifty. Should the frigate be fallen in with in a good working breeze, the steamer can only choose distance (and that only in case of being faster), but has still less opportunity of selecting position.

Even if we grant the steamer the claimed choice of position, the advantages to be derived from this are not by any means evident; the sterns of ships are no longer made for ornament alone; a frigate can in half a minute shift six guns from her broadside to her stern, which is, in proportion to its development, as formidable a battery as her broadside; added to which, the steamer being herself in motion at a rapid rate across the line of fire, delivers her shot at a greater disadvantage than the sailing ship, which is either quiet or slowly rotating on her heel. Steamers when not under sail are particularly uneasy in a sea-way, making the pointing their guns very difficult.

But, say the advocates of the steamer, she being armed with larger and heavier guns, will lay off abeam out of danger, and hammer her adversary without caring to choose position. This is another assumption not borne out by the facts. The steam frigates *Saranac* and *San Jacinto** each mount six eight-inch guns; four in broadside, the other two on pivot carriages; the whole may be fought on one side.† The first class frigates mount each fifty guns; eight of which are eight-inch, the remaining forty-two are of 32 lbs. calibre; by shifting over, thirty-two guns may be fought on one side. The two pivot guns are of slightly greater power than any gun on board the frigates *as now armed*, but not to such an extent as to overcome the disparity of six to thirty-two. This disparity in numbers must always exist, for the steamers are already loaded down with their machinery and battery, and any increase of guns requires a corresponding addition of men, ammunition, and provisions. The disparity in the power of the guns may be met by putting corresponding guns on the frigates; this has been done in the case of the small frigate *Raleigh*, which mounts two heavy eight-inch guns on pivots, twenty common eight-inch shell guns, and two long thirty-two pounders. We must confess that on comparing this ship with the *Saranac* or *San Jacinto*, we cannot believe that any advantages of position likely to be obtained by the steamer can compensate for her decided inferiority of four to one in military force.

The *Mississippi*, carrying no long guns, is, in our opinion, decidedly inferior to the preceding steamships; while the *Susquehanna* and *Powhattan* are but larger editions of the *Saranac*, and in force, as in cost, are only to be compared with ships of the line. As to the *Princeton*, her armament of four light eight-inch guns, and six light thirty-two pounders, is decidedly inferior to that of any first class sloop in the navy. The first class sloops mount twenty-two guns of greater power, and would bore her through and through before she could effectively return a shot.

The favorite policy of keeping at a distance led to a preference of a few guns, and those of great calibre, more particularly adapted to the firing of shells. There are, however, certain practical difficulties in the handling of heavy guns and their shot, which very much diminish their theoretical superiority over the thirty-two, which is the calibre generally used in the frigates. In mere *range*, the eight and ten inch guns are not equal to the thirty-two, as may be shown by reference to the Ordnance Manual; and being armed with shell guns, to the exclusion of solid shot, except at short ranges, the steamship is within the reach of shot long before her guns would tell. Shells are very far inferior in both range and accuracy to shot, and in view of this, the preference of shell guns does not appear to rest on a sound basis, but is a mere theory; they are as yet untried in actual warfare, and the records of authentic practice show that not more than one-fifth the shells fired at a target placed at a known distance, explode satisfactorily. The frigate, therefore, has at great distance numerous solid shot guns for deliberate fire, and at closer quarters, a broadside of either, or a mixed volley of shot and shell, with a numerical superiority of six to one.

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* We prefer choosing illustrations, when practicable, from our own service.

† This is, however, at sea, a questionable advantage; the heel towards the enemy caused by shifting over permits the deck to be commanded.

The heavy guns placed on the bows and sterns of steamships, are necessarily mounted on pivot carriages on the spar deck, which makes it necessary to remove the bulwarks, either entirely, as in the *Saranac*, or partially as in other steamers. This exposes the *personnel* at all distances to effects of shell, and particularly the spherical case or shrapnel shell, and at close quarters to grape. The eight-inch spherical case, containing about 400 missiles, may be employed at a range of 2500 yards, a distance beyond the effective range of any other species of projectile. The principal battery of the frigate is entirely protected, and the spar deck except from a raking position, in which last case, the exposed guns being inoperative may be temporarily abandoned, and the men sheltered.

We have now to consider the steamer when forming a part of a fleet. Here, forming a part of the line of battle, the integrity of the formation must be preserved; she has no opportunity of selecting her position; her usefulness is dependent on her absolute force, and she may be crushed at once by the superior ship to which she is opposed. If she keeps aloof, or acts the part of a tow-boat, her armament is inoperative, and she renders no service to compensate for her cost. But she cannot be depended upon for towing; she may be disabled, or the tow-rope may be cut by shot; this last is not a hypothetical case, for the loss of a Danish ship of the line during the late troubles with the Dutchies, was owing to this cause. The tow cannot be under sail; consequently, once adrift while making sail, she is, for a short time at least, an unresisting target. The true position of the steamship is as a reserve for assisting disabled vessels, not a principal actor in the fight.

There is one point in the paragraph we have quoted which we have not as yet attempted to dispose of. That "steamers can back out of difficulties and dangers, when sailing vessels must remain exposed," we must in the abstract admit; but in order to give them this faculty there is no necessity of depriving them of four-fifths of the military force due to their tonnage. In the side-wheel steamship in our service, the engines and fuel occupy nearly, if not quite, half the whole space beneath the water-line. In the *Princeton*, if all her fuel was below, not less than three-fifths of her entire capacity would be occupied by machinery, fuel, and stores; so that no economy of space, at least in this instance, is gained by the propeller. The English steam frigate *Arrogant*, which has become quite familiarly known to the readers of this *Journal*, and celebrated for her efficiency, carries but forty guns, when the battery due to her tonnage is sixty; to compensate for this diminished force, she carries but eight days' coal, steaming at sea at a maximum rate of 5.08 knots (*Vide Jour. Frank. Inst., May*, 1852). This is probably the maximum rate at which it is necessary that a war steamer should be propelled; it is ample for all the purposes of manœuvring, and for making head against the most rapid currents of the ocean. The boilers and machinery necessary occupying but a limited space, may be placed with, say ten days' coal, far below the water-line, and when necessary, fifteen to twenty days' coal may be carried in bags. The risk of accident, which forms so serious an item to their disadvantage, to be allowed for in comparing the efficiency of the present steamers, is reduced to a mere trifle. Further improvements may be expected in the engines and boilers, and models of the ships (the *Arrogant* is by no means a good model), and we may succeed in giving a steamship this velocity without displacing so great a portion of her battery as to seriously affect her force.

To the present time, then, we assert that military efficiency has been sacrificed to speed, without attaining the latter, and nothing but a mongrel has been produced, as must always be the case when we aim to combine in one, several contradictory qualities. We require for one purpose, great military force, with sufficient power to render it available when calms, contrary winds, or adverse currents prevent our approaching in sailing vessels the object to be attacked; and for the other, great speed, room for the accommodation of troops, and moderate draft of water.

The first is to be obtained by applying to every ship a small propelling apparatus, the drag of which will not materially effect her sailing qualities when not steaming, but which will be sufficient to manœuvre her in presence of the enemy, enable her to enter ports, or pass through regions of calms to those of favorable winds.

For dispatch vessels and troop ships, the mail steamships now in existence under contract with the government, are admirably adapted; they can carry a sufficient battery for the purposes of defence, and their speed insures them impunity where superior force is concerned. It is unnecessary to discuss in this paper, whether it is a wiser policy to continue the subsidies to these steamers and establish new lines of similar vessels, or to build vessels of similar qualities, or to trust to the natural development of commerce. We have combated what we believe to be false positions and fallacious arguments, and have indicated the wants and requirements of the Naval Service. The facts are indisputable, the inferences we think legitimate.

Naval officers are, of all others, most interested in this subject, for they feel that much will be expected of them in a future war, and they *know* that the means placed at their disposal are not capable of producing the required effect.

[From the (Cincinnati) Railroad Record.]

Railroad Accidents, their Causes and Prevention.

THE investigation of the number, causes, and modes of preventing railway accidents, is one of the most important elements of what may be called railway science. It is known that the hazards of a traveller are much less by railway than by any other mode of conveyance. *But*, what that proportion is, and whether it may not be still further diminished, are yet open questions. In the reports made by the New York railways to the State Engineer, we have some valuable data, by which to determine the actual danger of accident by railway. The returns of *thirty* railroads in New York give us the following elements of calculation:

Length of miles run	1,858¾	
Number of miles run by trains	4,421,449	
Passengers carried	7,440,653	
Whole number of persons injured—Killed	162	
Wounded	103	
	—	265
Passengers—Killed	28	
Wounded	56	
	—	84
Employees—Killed	60	
Wounded	29	
	—	89
Other persons—Killed	76	
Wounded	18	
	—	94

Now, before we analyze the causes of these accidents, we should notice a very great difference in the *fatality* of these accidents, as to the different classes of people injured. The proportion of *employees* killed to those merely wounded, is *four times as great as in the class of passengers*. So also the proportion of "others"—that is of *outsiders*, coming in conflict with the cars—fatally injured is yet larger. The general cause of this is obvious. If a collision or violent accident occurs to a train, the engineer and brakeman are obviously in the most exposed position, and if injured at all will probably be killed. So, also, when outsiders are injured; it is because they are on the track in the way of the train, or attempting to get on a train in motion, both of which are the most dangerous positions and the most likely to cause fatal accidents. Thus, it appears, that of the whole number injured, less than *one-third* are passengers; and of those killed only *one-sixth* are passengers.

Of the whole number of passengers carried in one year, it appears that less than *one in nine thousand* are injured at all; and less than *one in twenty-eight thousand* injured fatally. Even this small number is, we admit, more than it ought to be, and much more than it will be, in a well-regulated railway system.

The first question in the examination of the *causes* of railway accidents is—were they occasioned by the fault of the passenger, or by the fault of the railroad? If the former, there is no reason why they should be charged to the account of the railroad, more than to any other cause. Men will be imprudent and careless wherever they are; and nothing illustrates this better than the extreme *carelessness* which has occasioned one-half of railroad injuries. Taking the passenger list first, we find that the fatal injuries were occasioned in the following manner:

Jumping on or off the trains when in motion	18
Fell or were thrown off the trains	4
Collision of trains	6
Trains thrown from the track	4
Standing upon the platform	1
	28

Now, it is plain that the deaths of the first and last classes were caused *solely by the passengers' own fault.* There are *notices* put up in the cars of most good roads, that passengers should not leave the cars when in motion, or stand on the platforms. The whole number of deaths among the passengers from railway causes is, then, properly reduced to 14, only one-half, or about one in 53,150 of those carried in one year.

The large class of "others," or those not in the cars, fatally injured, is quite a remarkable phenomenon in railway history. Let us examine the causes:

Run over while walking or standing on the track, and killed,	68
Standing by trains, killed	1
Killed at road crossings	2

"*Run over*" comprehends nearly the whole cause of accidents to *outsiders.* But why should a person be *run over?* This can hardly be the fault of the railroad managers, for all persons have ample notice of the approach of the cars.

In examining the individual instances of this species of accident, we find that several persons so injured were intoxicated; others were deaf; some were children; and that many were men engaged on or near the track, and did not take timely care in getting out of the way.

The inferences from these facts are:

1st. Of all the persons in or about a railway, the passengers are in much the safest position.

2d. That the number of passengers injured is very small in proportion to the number carried; and that of all modes of public conveyances, railways are the safest.

3d. That of accidents to passengers, full one-half are caused by their own gross negligence, and violation of the rules laid down for their observance.

4th. That of persons injured outside the cars, the majority were so injured by their own fault, in not taking timely care, or in being intoxicated.

5th. From the special returns of the companies, we find that most of the "running off the track," or being thrown off the track, was caused by animals on the track.

6th. Children on the track and injured, was caused by the want of fencing.

7th. From the last two facts, it is plain that a *preventive* to a large number of accidents, would be a *strong and continuous fencing.* We hope to see this universally adopted.

8th. The most dangerous cause of legitimate accidents is "*collision.*" A preventive of this, almost entirely, would be *double tracks;* and this, also, we hope, will be adopted, on every considerable railway in the country.

If railways were entirely and strongly fenced, and if they had double tracks, we feel persuaded that the hazard to passengers would be almost nothing, except in cases of their own gross fault.

As a general rule, the conductors and engineers on passenger trains are remarkably careful; and it is rare that an accident occurs from any negligence of theirs. One great fault, however, in American railways, is the want of a general and systematic police, and this should be remedied.

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The Imperfections of Mechanism—Instruments.

BY SIR JOHN F. W. HERSCHEL, F. R. S., &C.

ASTRONOMICAL instrument-making may be justly regarded as the most refined of the mechanical arts, and that in which the nearest approach to geometrical precision is required, and has been attained. It may be thought an easy thing, by one unacquainted with the niceties required, to turn a circle in metal, to divide its circumference into 360 equal parts, and these again into smaller subdivisions,—to place it accurately on its centre, and to adjust it in a given position; but practically it is found to be one of the most difficult. Nor will this appear extraordinary, when it is considered that, owing to the application of telescopes to the purposes of angular measurement, every imperfection of structure or division becomes magnified by the whole optical power of that instrument; and that thus, not only direct errors of workmanship, arising from unsteadiness of hand or imperfection of tools, but those inaccuracies which originate in far more uncontrollable causes, such as the unequal expansion and contraction of metallic masses, by a change of temperature, and their unavoidable flexure or bending by their own weight, become perceptible and measurable. An angle of one minute occupies, on the circumference of a circle of 10 inches in radius, only about $\frac{1}{340}$th of an inch, a quantity too small to be *certainly* dealt with without the use of magnifying glasses; yet one minute is a gross quantity in the astronomical measurement of an angle. With the instruments now employed in observatories, a single second, or the 60th part of a minute, is rendered a distinctly visible and appreciable quantity. Now, the arc of a circle subtended by one second, is less than the 200,000th part of the radius, so that on a circle of 6 feet in diameter it would occupy no greater linear extent than $\frac{1}{5000}$th part of an inch; a quantity requiring a powerful microscope to be *discerned* at all. Let any one figure to himself, therefore, the difficulty of placing on the circumference of a metallic circle of such dimensions (supposing the difficulty of its construction surmounted) 360 marks, dots, or cognizable divisions, which shall be true to their places within such minute limits; to say nothing of the subdivision of the degrees so marked off into minutes, and of these again into seconds. Such a work has probably baffled, and will probably forever continue to baffle, the utmost stretch of human skill and industry; nor, if executed, could it endure. The ever varying fluctuations of heat and cold have a tendency to produce not merely temporary and transient, but permanent, uncompensated changes of form in all considerable masses of those metals which alone are applicable to such uses; and their own weight, however symmetrically formed, must always be unequally sustained, since it is impossible to apply the sustaining power to *every part* separately; even could this be done, at all events force must be used to move and to fix them; which can never be done without producing temporary and risking permanent change of form. It is true, by dividing them on their centres, and in the identical places they are destined to occupy, and by a thousand ingenious and delicate contrivances, wonders have been accomplished in this department of art, and a degree of perfection has been given, not merely to *chefs d'œuvres*, but to instruments of moderate prices and dimensions, and in ordinary use, which, on due consideration, must appear very surprising. But though we are entitled to look for *wonders* at the hands of scientific artists, we are not to expect *miracles.* The demands of the astronomer will always surpass the power of the artist; and it must, therefore, be constantly the aim of the former to make himself, as far as possible, independent of the imperfections incident to every work the latter can place in his hands. He must, therefore, endeavor so to combine his observations, so to choose his opportunities, and so to familiarize himself with all the causes which may produce instrumental derangement, and with all the peculiarities of structure and material of each instrument he possesses, as not to allow himself to be misled by their errors, but to extract from their indications, as far as possible, all that is *true*, and reject all that is erroneous. It is in this that the art of the practical astronomer consists,—an art of itself of a curious and intricate nature, and of which we can here only notice some of the leading and general features.

The great aim of the practical astronomer being numerical correctness in the results of instrumental measurement, his constant care and vigilance must be directed to the detection and compensation of errors, either by annihilating, or by taking account of, and allowing for them. Now, if we examine the sources from which errors may arise in any instrumental determination, we shall find them chiefly reducible to three principal heads:

1st. External or incidental causes of error; comprehending such as depend on external, uncontrollable circumstances; such as fluctuations of weather, which disturb the amount of refraction from its tabulated value, and, being reducible to no fixed law, induce uncertainty to the extent of their own possible magnitude; such as, by varying the temperature of the air, vary also the form and position of the instruments used, by altering relative magnitude and the tension of their parts; and others of the like nature.

2dly. *Errors of observation;* such as arise, for example, from inexpertness, defective vision, slowness in seizing the exact *instant* of occurrence of a phenomenon, or precipitancy in anticipating it, &c.; from atmospheric indistinctness; insufficient optical power in the instrument, and the like. Under this head may also be classed all errors arising from momentary instrumental derangement,—slips in clamping, looseness of screws, &c.

3dly. The third, and by far the most numerous class of errors to which astronomical measurements are liable, arise from causes which may be deemed instrumental, and which may be subdivided into two principal classes. The *first* comprehends those which arise from an instrument not *being* what it professes to be, which is *error of work-*

manship. Thus, if a pivot or axis, instead of being, as it ought, exactly cylindrical, be slightly flattened, or elliptical,—if it be not exactly (as it is intended it should) concentric with the circle it carries; if this circle (so called) be in reality *not* exactly circular, or not in one plane;—if its divisions, intended to be precisely equidistant, should be placed in reality at unequal intervals,—and a hundred other things of the same sort. These are not mere speculative sources of error, but practical annoyances, which every observer has to contend with.

The *other* subdivision of instrumental errors comprehends such as arise from an instrument not being placed in the *position* it ought to have; and from those of its parts, which are made purposely movable, not being properly disposed *inter se.* These are *errors of adjustment.* Some are unavoidable, as they arise from a general unsteadiness of the soil or building in which the instruments are placed; which, though too minute to be noticed in any other way, become appreciable in delicate astronomical observations: others, again, are consequences of imperfect workmanship, as where an instrument once well adjusted will not remain so, but keeps deviating and shifting. But the most important of this class of errors arise from the non-existence of natural indications, *other* than those afforded by astronomical observations themselves, whether an instrument has or has not the exact position, with respect to the horizon and its cardinal points, the axis of the earth, or to other principal astronomical lines and circles, which it ought to have to fulfil properly its objects.

Now, with respect to the first two classes of error, it must be observed, that, in so far as they cannot be reduced to known laws, and thereby become subjects of calculation and due allowance, they actually vitiate, to their full extent, the results of any observations in which they subsist. Being, however, in their nature casual and accidental, their effects necessarily lie sometimes one way, sometimes the other; sometimes diminishing, sometimes tending to increase the results. Hence, by greatly multiplying observations, under varied circumstances, and taking the *mean or average* of their results, this class of errors may be so far *subdued*, by setting them to destroy one another, as no longer sensibly to vitiate any theoretical or practical conclusion. This is the great and indeed only resource against such errors not merely to the astronomer, but to the investigator of numerical results in every department of physical research.

With regard to errors of adjustment and workmanship, not only the *possibility*, but the *certainty*, of their existence, in every imaginable form, in all instruments, must be contemplated. Human hands or machines never formed a circle, drew a straight line, or erected a perpendicular, nor ever placed an instrument in *perfect* adjustment, unless accidentally; and then only during an instant of time. This does not prevent, however, that a great approximation to all these desiderata should be attained. But it is the peculiarity of astronomical observation to be the *ultimate means of detection* of all mechanical defects which elude by their minuteness every other mode of detection. What the eye cannot discern, nor the touch perceive, a course of astronomical observations will make distinctly evident. The imperfect products of man's hands are here tested by being brought into comparison with the perfect workmanship of nature; and there is none which will bear the trial. Now, it may seem like arguing in a vicious circle, to deduce theoretical conclusions and laws from observation, and then to turn round upon the instruments with which those observations were made, accuse them of imperfection, and attempt to detect and rectify their errors by means of the very laws and theories which they have helped us to a knowledge of. A little consideration, however, will suffice to show that such a course of proceeding is perfectly legitimate.

The steps by which we arrive at the laws of natural phenomena, and especially those which depend for their verification on numerical determinations, are necessarily successive. Gross results and palpable laws are arrived at by rude observation with course instruments, or without any instruments at all; and these are corrected and refined upon by nicer scrutiny with more delicate means. In the progress of this subordinate laws are brought into view, which modify both the verbal statement and numerical results of those which first offered themselves to our notice; and when these are traced out, and reduced to certainty, others, again, subordinate to them, make their appearance, and become subjects of further inquiry. Now, it invariably happens (and the reason is evident) that the first glimpse we catch of such subordinate laws—the first form in which they are dimly shadowed out to our minds—is that of *errors.* We perceive a discordance between what we *expect* and what we *find.* The first occurrence of such a discordance we attribute to accident. It happens again and again; and we begin to suspect our instruments. We then inquire, to what amount of error their determinations can, *by possibility*, be liable. If their *limit of possible error* exceed the observed deviation, we at once condemn the instrument, and set about improving its construction or adjustments. Still the same deviations occur, and, so far from being palliated, are more marked and better defined than before. We are now sure that we are on the traces of a law of nature, and we pursue it till we have reduced it to a definite statement, and verified it by repeated observation, under every variety of circumstances.

Now, in the course of this inquiry, it will not fail to happen that other discordances will strike us. Taught by experience, we suspect the existence of some natural law, before unknown; we tabulate (i. e. draw out in order) the results of our observations; and we perceive, in this synoptic statement of them, distinct indications of a regular progression. Again, we improve or vary our instruments, and we lose sight of this supposed new law of nature altogether, or find it replaced by some other, of a totally different character. Thus we are led to suspect an instrumental cause for what we have noticed. We examine, therefore, the *theory* of our instrument; we suppose defects in its structure, and, by the aid of geometry, we trace their influence in introducing *actual errors* into its indications. These errors have *their laws*, which, so long as we have no knowledge of causes to guide us, may be confounded with laws of nature, and are mixed up with them in their effects. They are not fortuitous, like errors of observation, but, as they arise from sources inherent in the instrument, and unchangeable while it and its adjustments remain unchanged, they are reducible to fixed and ascertainable forms; each particular defect, whether of structure or adjustment, producing its own appropriate *form* of error. When these are thoroughly investigated, we recognize among them one which coincides in its nature and progression with that of our observed discordances. The mystery is at once solved: we have detected, by direct observation, an instrumental defect.

It is, therefore, a chief requisite for the practical astronomer to make himself completely familiar with the *theory* of his instruments, so as to be able at once to decide what *effect* on his observations any given imperfection of structure or adjustment will produce in any given circumstances under which an observation can be made. Suppose, for example, that the principle of an instrument required that a circle should be exactly concentric with the axis on which it is made to turn. As this is a condition which no workmanship can fulfil, it becomes necessary to inquire what errors will be produced in observations made and registered on the faith of such an instrument, by any assigned deviation in this respect; that is to say, what would be the disagreement between observations made with it and with one absolutely perfect, could such be obtained. Now, a simple theorem in geometry shows that, whatever be the extent of this deviation, it may be annihilated in its effect on the result of observations depending on the graduation of the limb, by the very easy method of reading off the divisions on two diametrically opposite points of the circle, and taking a mean; for the effect of eccentricity is always to increase one such reading by just the same quantity by which it diminishes the other. Again, suppose that the proper use of the instrument required that this axis should be exactly parallel to that of the earth. As it never can be *placed* or remain so, it becomes a question, what amount of error will arise in its use from any assigned deviation, whether in a horizontal or vertical plane, from this precise position. Such inquiries constitute the theory of instrumental errors; a theory of the utmost importance to practice, and one of which a complete knowledge will enable an observer, with very moderate instrumental means, to attain a degree of precision which might seem to belong only to the most refined and costly.

Tunnels—The Hoosac and others.

The applicants for the $2,000,000 loan to the Troy and Greenfield Railway have been lately having a hearing before a committee of the Massachusetts Legislature. We take from the Boston Daily Herald a report of the examination of James Hayward, engineer, and formerly teacher of Mathematics in Harvard University. He has visited Europe, and examined as many as thirty tunnels. During his visit he made the acquaintance of several eminent engineers, and supplied himself with profiles of several tunnels. The profile of the Marseilles tunnel he exhibited to the committee. It is located at Nerthe, near Marseilles, is three miles (15,153 feet) long, and has twenty-four shafts. The material in this tunnel is a very hard limestone. The height of the ground over it is a little over 600 feet. The aggregate length of all the shafts is 7589 feet; the deepest shaft is 610 feet. The cost per yard down, for excavation, was $43. The shafts are nine feet in diameter, and are lined with masonry, at a cost of $19.40 per yard down.

Mr. Hayward obtained from the engineer in charge of the work, the prices which the work cost. The deepest shaft cost $73 per yard down, entirely completed. The entire cost of all the shafts, for the masonry, amounted to $47,000; and $150,000 for the whole cost of the tunnel. The entire cost of the tunnel for the contractor was $125 for the lineal yard; this includes shafts. The tunnel was lined with masonry of different thicknesses, and cost $123,000. The entire cost of the tunnel, exclusive of masonry, was $705,000. The contractor, however, gave Mr. Hayward a less price, about 4 per cent., as having been the actual cost.

It would be undoubtedly more comfortable to work on the Hoosac than on the Marseilles Tunnel. It is a very large tunnel, some 50 per cent. larger than is usually surveyed for double tracks. It is greater by nearly double, than the Hoosac; its height is 29½ feet, width, 26¾ feet. There is no difficulty experienced in passing through the tunnel in the cars. The train creates a draft of air and there is nothing unpleasant in the passage.

Railroad work generally, in England, is not done very much less than in this country. Engineers and persons having authority, are better paid than they are here.

Mr. Hayward gave an explanation of the Woodhead Tunnel between Manchester and Sheffield. It is a little over three miles long, and the hill over is 600 feet high. It has five shafts, 10 feet in diameter, which vary from 400 to 600 feet in depth. The character of the rock is granite, not so hard as our granite; it is called there "Mill-stone rock." The Tunnel was about five years in construction, and its whole cost was $1,026,705.

There are various ways of ventilating the Tunnel while the miners are at work, and it is easily done. It was supposed that the shafts would be necessary for ventilation in the Woodhead Tunnel, as the cars passed through it, but they are now closed. Mr. H. gave an explanation of the various modes that are adopted for ventilation. In the mines in Cornwall, there are excavations extending 30 miles under ground. There are tunnels in the Duke of Bridgewater's Canal, which make, in the aggregate, thirty miles. On the Thames and Medway Canal, there is a tunnel more than double the area of the Hoosac Tunnel. It is about two miles long, and contains more cubic yards than the Hoosac Tunnel. The shafts by which it was originally constructed, except one in the centre, are closed. The tunnel is used both for a railway and canal, and trains pass through it every half hour daily. Gen. Paisley, the superintendent of public works, passed nearly a day in the tunnel, and he says that the smoke and steam from the trains, as well as smoke from the lamps used, passed almost immediately away. There was a constant current of air through it.

The box tunnel, which is one of the earliest, and is the largest and most expensive tunnel ever constructed, is 39 feet high and over 30 feet wide. The tunnel is on the Great Western Railway, about 100 miles from London. The shafts were 25 feet in diameter, its length is 9579 feet. Over one third of it is through the solid rock. Robert Stevenson of England, who is considered as standing at the head of railroad engineers in Europe, visited the place for a proposed tunnel under the Alps, and told the witness that he, Stevenson, had given a report favorable to the project.

Mr. Hayward had in his possession a report of Chevalier Maus, the engineer of the proposed Alps Tunnel. It is at Mount Cenis; the mountain rises 5000 feet above the line of the tunnel, and it is $7\frac{8}{10}$ miles long. The grade of the tunnel is all to be one way, and it is to be 105 feet to the mile. It is proposed to do the work by machinery,—to take the stone out in blocks. The power used is water power, there being a brook at each end of the tunnel. Mr. Maus speaks with entire confidence of going through with the tunnel in 5 years, and estimates the cost at 13,804,943 francs.

Mr. Hayward gave from his notes, some memoranda of the cost of tunnels he had visited in England. Upingham Tunnel, 1320 feet in length, cost £25 per lineal yard. At this rate, Hoosac would cost, $1,807,500. At the rate Chippencamden Tunnel cost, Hoosac would cost $1,854,876. Pulpit Rock Tunnel, Pa.,—a difficult tunnel on the Reading road—cost $66.20 per lineal foot. At this rate, Hoosac would cost $1,026,705. Gen. Bernard gave to Mr. Baldwin, in answer to some inquiries, the cost of five tunnels, the highest of which was $1.36 per cubic yard. At this rate, Hoosac would cost $1,706,920.

The estimate of the Engineer as to the cost of Hoosac Tunnel, Mr. Hayward regarded as very liberal. $2,000,000 he thought was a very liberal estimate; it would leave a very large margin for contingencies.

The Tunnel, with forty miles of railroad connected with it, would, in the opinion of Mr. Hayward, be a sufficient security to the State. There was no difficulty in meeting by excavating both ends of the tunnel. It could be done with great exactness. He recollected to have read a short time since of two men meeting in a tunnel, their largest variation being not more than two inches.

Mr. Hayward was cross-examined at some length, but few facts possessing sufficient interest for publication were elicited.

At a subsequent meeting of the committee, Mr. Hayward, the Engineer, gave some further particulars concerning the Nerthe Tunnel, near Marseilles. This tunnel is 15,153 feet; its width 26¾; height 29½ feet in the clear. It has 24 shafts of an aggregate length of 7589 feet; the deepest of which is 610 feet, and they are lined with masonry. They are nine feet ten inches in diameter inside the line. A portion of the body of the tunnel is lined with masonry, one, two, and three bricks thick; another portion is not lined at all.

The cost of mining the tunnel proper, was $139 76½ per yard forward. The actual cost to the contractor, for mining, including shafts, was $125 per yard forward. Besides this, there is a semi-circular brick aqueduct 4½ inches in diameter, running the whole length the tunnel under the floor.

The actual cost of the Nerthe Tunnel, according to the engineer's statement, is as follows:

For mining the body of the tunnel	$705,982 20
For mining the shafts	109,081 08
Masonry for shafts	49,069 31
Lining the body of the tunnel	423,711 18
Cost of aqueduct	10,607 10
Whole cost according to engineer's estimate	$1,298,450 87

Actual cost of the Nerthe Tunnel to the contractors, $1,114,763 00.

At the engineer's estimate for the Nerthe Tunnel, the Hoosac Tunnel, including aqueduct, would cost $2,065,113 58.

At the prices stated by the contractors, the Hoosac would cost $1,772,968. 20.

But the proposed tunnel is not more than two-thirds as large as the Nerthe in the area of its section. This would seem to justify a deduction of one-third from the above sum; but if one-fourth is deducted, we should have for the cost of Hoosac, according to the engineer's statement, $1,558,835 19.

According to contractor's statement, $1,329,726 23.

Nerthe Tunnel contains more cubic yards than Hoosac, and is little more than one quarter less in length. In the judgment of Mr. Hayward, the excavation at Hoosac would not be so much disturbed by water as at the Nerthe.

The stone in England is much more unfavorable for excavation than at Hoosac. If you have a solid rock to excavate, there is no danger of the earth running in. If you have loose earth, it is necessary to have walls overhead, and an inverted arch underneath. Mr. Hayward concluded his testimony by giving it as his opinion that the estimate of the tunnel could be as nearly come at as the estimate of the cost of an entire railroad.

H. G. Knight called—Is a machinist of 28 years' standing; is the inventor of the steam pile-driver and of a machine for drilling rocks. By this machine he can drill a hole 7 inches in diameter as fast as three men can drill a hole 4 inches; with it he can drill a foot an hour in granite rock. Mr. Knight has visited McGinnis's shaft in Pottsville. The shaft is 14 feet by 18 feet, and was, three months ago, 270 feet deep. The rock there is harder than granite. They sink the shaft a foot every eight hours, or three feet a day; has seen the Hoosac rock, and has drilled it. It is very soft and easy; could drill 30 or 40 feet without sharpening the drill; with this machine drill, he could have worked the Pottsville shaft as fast again as he saw it worked. With it he could sink a shaft at Hoosac at a rate of more than 5 or 6 feet a day. The machine is in use on important work, in various parts of the country.

Henry Goulding, a machinist—Has got up a machine for horizontal drilling, and has drilled at Somerville with it, in hard limestone, at the rate of 10 feet an hour in a two-inches drill; it was a new machine, and was not run more than 20 minutes at a time; has built two; the first machine was cumbersome, larger than there was any necessity for; a new machine of less size is now being set up at No. 2 Andover Street; the machine is run with a four-horse power engine.

John A. Carpenter, called—His business is the construction of railroads, under the firm of Gilmore & Co., and Gilmore, Belknap, & Co. First engaged in railroad work in 1834. The firms with which he is connected have built four hundred miles of railway. Have done a great deal of heavy rock work. Constructed the dam and canal at Lawrence and the foundation for the Bay State Mills. This work contains from 100 to 125,000 perch (a perch is 2 feet less than a cubic yard; the perch contains 25 feet, the cubic yard 27 feet). Has built two tunnels, that at Salem and that at Newburyport, the only tunnels at present built in Massachusetts. Has contracted with the Troy and Greenfield road for two short tunnels, one at North Adams, the other at a place between Greenfield and Shelburne Falls. The contract price is $3 per cubic yard, each to be paid one-half in cash, one quarter in bonds, and one quarter in stock. Have made an offer to the company to construct the Hoosac Tunnel, at the rate of $4.50 per cubic yard. That contract is yet open. The estimate includes the whole work, and a sufficient margin was made they think, for contingencies and profits.

Dr. Jos. C. Bachelder, one of the owners of the machine, testified —In our contract with the original owners of the machine we stipulated to put the machine into operation and expend a considerable sum of money. We expended that sum and a considerable over, and the machine stopped work by consent of parties. It came to a stand still in November. The Railroad Company gave us to understand that they would hardly be able to go on, without money, even if they were ready. The railway company have given us $1200 cash paid in, and we have had their assistance in conveying the machine to the mountain. The machine was ready to operate by the 15th August. We did not prosecute the work immediately, because we found it advisable to make some alterations in the machine. Three feet is the utmost depth we can cut with it, before blasting. When we have got into the solid rock there is no danger in blasting, to the roof. Has seen nothing to impair his confidence in the working of the machine, or of progressing 6 or 7 feet a day with it. There are 10 feet between the wheels, and we can run a railway car between them to remove the material from the tunnel. We have a contrivance by which we can easily lift stone 5 or 6 tons in weight on to a platform car. The whole cost of the machine, including apparatus and expenses, thus far has been about $25,000. It is owned by Messrs. Richards, Mann & Co., and Messrs. Williston, Butler and myself.

A. J. Edwards, engineer of the Troy and Greenfield Railroad, was recalled to put in evidence a table of curvatures on the Troy and Greenfield road and the Western road. The table draws a comparaison of curvatures on the Western road, between Greenbush and Springfield, and between the Hudson and Connecticut Rivers on the Troy and Greenfield road:

	Miles.
Distance on the Western road from Greenbush to Springfield,	102
Distance on the Troy and Greenfield from Hudson River to Connecticut River,	82
Degrees of curvature on Western road,	5,664
Degrees of curvature on Troy and Greenfield road via Tunnel,	3,142
Excess of degrees of curvature on the Western Railroad,	2,522

which is equal to more than seven entire circles (360 degrees), more than the Troy and Greenfield road. The shortest radius of curvature on the Western road is 822 feet. Shortest radius of curvature on the Troy and Greenfield road is 1228 feet, and there is but one curve of this length. Except in 500 feet in a curve of 1300 feet, there is no curve less than four degrees on the entire route.

Total elevations on the Western Railroad, rise and fall, are	3,420 feet.
Total elevations, rise and fall, on the Troy and Greenfield road, are	1,598 feet.
Excess on Western road,	1,822 feet.

or double the elevations on the Troy and Greenfield, and 224 feet in addition. The maximum grade of the Western Railroad is 83 feet to a mile. The maximum grade of the Troy and Greenfield is $31\frac{64}{100}$ feet in Massachusetts, $26\frac{4}{10}$ feet in Vermont, and $39\frac{4}{10}$ feet in New York. The grade of the Western road at the State line in New York, is 50 feet higher than the Hoosac Tunnel. The grade of the Western at the summit, is 640 feet higher than the Tunnel.

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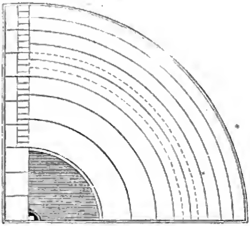
[From the Journal of the Franklin Institute.]

Theory of the Main-Spring of a Watch.

BY ALEXANDER YOUNG, CAMDEN, U. S.

FIG. 1, is an enlarged sketch of one-fourth part of the spring barrel of a watch. It is laid off into nine equal spaces, eight of which are to show the theory of the action of the spring. The centre space is for the arbor, and is one-third of the diameter. There is a scale of twenty-four equal parts, corresponding to the thickness of the spring, which is estimated by the proportion it bears to the diameter of the barrel: suppose it to be 72 to 1. Two coils of the spring placed in the outside space will then fill it, and if wound on the arbor will fill the inside space, making five coils; if it is attached to the barrel and arbor, as usual, it will cause three revolutions in expanding back to its first position. Nineteen coils will fill the seven outward spaces; and if wound on the arbor, the seven inward spaces with twenty-two coils; having the same difference and revolutions as above, but with greater power, and the action will be more uniform. Nine and one-sixth coils will fill the four outside spaces, and when wound on the arbor, the four inside spaces increased by five and two-thirds coils. The spring has most action when it fills four spaces, or half the barrel; if it extends to the middle of the fifth space, it will lose one-sixteenth; if to the whole five spaces, one quarter of a revolution, but will gain in power, and transmit it more uniformly. A scale for any thickness of spring can be applied to the same figure.

Fig. 1.



The following table gives the radii of the circles that divide the spring barrel into nine equal spaces; also, the revolutions taken from them, which are equal to the number of coils that the spring has when wound on the arbor over the number it has when expanded against the rim of the barrel. The two middle spaces are subdivided; the radii of the two circles and the revolutions made by those divisions are interlined.

Radii of the Circles.	Revolutions.	Radii of the Circles.	Revolutions.
36,000	——	25,455	5597
33,940	2910	24,000	5392
31,754	4581	20,777	4581
29,392	5392	16,970	2910
28,142	5597	12,000	——
26,832	5664	——	——

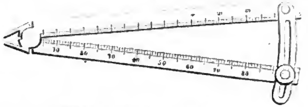
Fig. 2, shows the form of the callipers and sector combined; the long end is 4 inches, and is divided from the centre of the joint on both legs, into one hundred equal parts; the divisions opposite to 60, 70, and 80, are marked, 4, 5, and 6, corresponding to the number for the revolutions of the barrel. In the tables it has a clamp and screw limiting its opening to 1 inch. The short or calliper end is $\frac{4}{10}$ inch, opening to $\frac{1}{10}$ inch, or as ten to the distance across from any two corresponding numbers on each leg of the sector.

The following table shows how many revolutions of the barrel will be produced by the different thickness of the spring. A deduction is made for attachments at the ends, and for the soft part of the spring not unwinding from the arbor, and may amount to $\frac{1}{3}$d of a revolution for a spring of $\frac{1}{60}$th, and to $\frac{3}{4}$th, when it is $\frac{1}{84}$th of the diameter.

Coils of the Spring to the diameter of the Barrel.	Revolutions by Theory.	Revolutions by Experiment.
60	4·72	4·0
62	4·88	4·2
64	5·04	4·4
66	5·19	4·6
68	5·35	4·8
70	5·51	5·0
72	5·66	5·2
74	5·82	5·4
76	5·98	5·6
78	6·14	5·8
80	6·30	6·0
82	6·46	6·2
84	6·61	6·4

To select a spring for any number of revolutions, open the sector to the radius of the barrel, at the number on the scale for the required revolutions, the callipers will then just admit five coils of a spring when of a suitable thickness.

Fig. 2.



To find the weight of a spring for any size of barrel, take the inside diameter in hundreths of an inch, which is done by opening the sector to its limit, then apply the barrel cap to reach across from side to side, to the same numbers on the counterpart scales, which will be the diameter. The width of the spring is found in the same way. Then enter the table with the diameter of the barrel, take out the three opposite figures, and multiply by the width of the spring, which gives the weight in troy grains for a spring that will fill $\frac{7}{9}$ths of the barrel. The table is constructed by taking the area of the arbor from the area of the barrel in hundredths of an inch; $\frac{5}{9}$ths of the remainder multiplied by 1900 (the grains in a cubic inch of watch spring) give the numbers for the table. If the arbor is less than $\frac{1}{3}$d of the barrel, the callipers should fit tightly, and the spring have full weight; if larger the callipers should fit loosely, and the spring have short weight.

Table of the Diameter of the Barrel in Hundredths of an Inch.

50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
1·86	1·94	2·02	2·10	2·18	2·26	2·34	2·42	2·51	2·60	2·69	2·78	2·87	2·96	3·05	3·15	3·25	3·35	3·45	3·55	3·65	3·76	3·87	3·98	4·09	4·20

Weight of the Spring in grains, troy, for every Hundredth of an Inch in Width.

The next table is constructed by experiment with a spring $\frac{12}{65}$ inch wide, filling five spaces, or five ninths of a barrel, $\frac{67}{100}$ inch in diameter, of which the thickness of the spring is $\frac{1}{85}$, and weighs 45 grains. The barrel having the chain lapped round it with a scale for weights, and held fast by the arbor, when the weights are put in the chain will unroll; the weights required for each revolution are noted, and placed in the table.

Troy Ounces Sustained.

	5 Spaces Filled.	4½ Spaces Filled.	4 Spaces Filled.
	9	8	$7\frac{1}{4}$
	12	11	$10\frac{1}{4}$
	14	13	$12\frac{2}{4}$
	16	15	$14\frac{1}{4}$
	18	17	$16\frac{2}{4}$
Sum	69	64	$60\frac{3}{4}$
Number of revolutions	$5\frac{4}{9}$	$5\frac{5}{9}$	$5\frac{3}{9}$

The spring is then taken out, and its length reduced by breaking off 4½ grains; when replaced, proceed as before, placing the results in the second column of the table. Then remove another 4½ grains, leaving 36 grains of the spring. The weights applied as before, give the numbers for the third column of the table, which shows the intensity of the spring at the end of each of the five revolutions; when it fills 5, 4½, and 4 spaces.

The sum for each column gives the weight raised to a height equal to the circumference of the barrel. The greatest amount of power is obtained when the five spaces are filled; with four only, there will be more left over the five revolutions, but not sufficient to compensate for the loss of the power.

The spring of the best watches fills four and a-half spaces, and has a revolution over, to allow for straining up, and still leaving a part free. The sector, the table (which can be copied on a card), and a pair of small scales, with grain weights, are all that is required to select a spring that will have the desired number of revolutions, and the greatest power the capacity of the barrel will admit.

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[From the Civil Engineer and Architect's Journal.]

Iron Roof, Railway Terminus, Liverpool.

JOHN HAWKSHAW, ESQ., CIVIL ENGINEER.

[Paper read before the Royal Scottish Society of Arts.]

THIS roof has been erected at the Liverpool terminus of the Lancashire and Yorkshire Railway, under the superintendence of Mr. J. Hawkshaw, by Messrs. Fox, Henderson, & Co., of Birmingham. It covers five lines of rails and three platforms, and a carriage-road twelve yards wide, in one span, having no columns or supports besides the outside walls; the span varies from 136 to 128 feet over the walls, and the total length is 638 feet; the total area thus covered is 83,457 square feet, or 834 squares.

Fig. 1 shows an elevation of one of the principals of the roof. Figs. 2, 3, and 4, show details of the joint at the bottom of the centre king-rod. Figs. 5, 6, 7, and 8, show details of the joints of strut with rafter and tie-rod.

Fig. 1. Scale 1-16 of an inch = 1 foot.

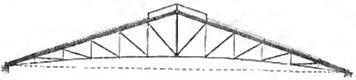


Fig. 2.

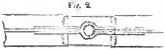


Fig. 3.

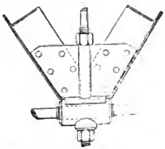


Fig. 4.

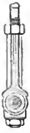


Fig. 5.

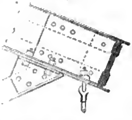


Fig. 8.

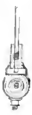


Fig. 6.

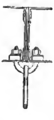
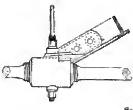


Fig. 7.



Scale for Figs. 2, 3, 4, 5, 6, 7, 8, ½ in. to a foot.

In the construction of large wooden roofs it is usual to form strong framed principals of timber of large scantlings, and to place them at distances of 10 to 16 feet apart, to act as the main supports for the roof. On these principals strong wood beams or purlins are placed, reaching from principal to principal, and on these purlins are placed the ordinary rafters of much lighter scantling, and these rafters receive laths or battens, on which the slates are ultimately fixed. It will thus be seen that there are five distinct members in an ordinary large wooden roof, viz. the principals, purlins, rafters, laths, and slates.

In the roof which is the subject of the present paper, there are three distinct members only, viz., the principals, purlins, and corrugated iron covering, and the arrangement is as follows:

Firstly. The principals are placed at 11 feet from centre to centre, and span across from wall to wall; each principal being provided with two cast-iron shoes, which are bedded into the top course of masonry of the wall, the distance from centre to centre of these shoes being 134 feet 8 inches at the widest part, and 125 feet at the narrowest part.

Secondly. The purlins, which are framed of wrought-iron of a ┳ section, are placed on the back of the principals, directly over the upper end of each strut, and reach from principal to principal; their own weight and the weight of the roof-covering upon them, is therefore immediately supported by the struts in the principals, so that there is no tendency to bend the back of the principal between the struts; the purlins thus form substantial longitudinal ties between the principals.

Thirdly. The covering of the roof, which is made of corrugated galvanized iron plate, is supported by the purlins without the aid of any other support, as it is strong enough to bear its own weight and the weight of snow, &c., on it without injury; its stiffness in a direction at right angles to the purlins being derived from its corrugated form, the corrugations running down the roof parallel with the principals. The sheets of corrugated iron are secured together by rivets with washers, and to the purlins by bolts and nuts; every plate being lapped over the one below it as in slating.

The backs of the principals, or "principal rafters," as they are termed, are formed of a wrought-iron plate, with two large pieces of angle-iron riveted along the top, one on each side, and two along the bottom, one on each side, thus forming a section like the figure annexed **I**, or, in fact, a regular girder section; this form gives ample width to receive the purlins on the top, and the struts on the bottom, and, at the same time, there is sufficient space on the bottom flange to receive the staples by which the queen-rods hang.

The struts in the principals are all of **T** iron of large sizes, and are secured at the upper ends to the "principal rafter" by means of stiff wrought-iron knees firmly riveted to them, and bolted to the "principal rafters;" at their lower end the struts are fixed into cast-iron shoes, which fit on the tie-rod and are fixed by the queen-rod.

The main tie-rods are of round iron, and are screwed into wrought-iron sockets or connecting pieces under each queen-rod, the queen-rod passing through it and being provided with a nut below; by which means the sockets and tie-rods are supported, together with the struts, which start from them as above described.

The upper ends of the "principal rafters" are secured in a strong cast-iron kinghead, formed of two castings firmly bolted together through the ends of the "principal rafters;" from this kinghead hangs the king-rod, and above it is fixed the centre louvre standard, which carries the cast-iron ridge-piece into which the upper ends of the sash-bars of the skylights are fixed.

Light is admitted through the roof by four continuous lines of skylights, two of which are placed at the ridge over the louvres, the other two being fixed near the eaves upon opposite sides; the ridge skylights are about 22 feet wide, and those at the eaves 10 feet each, making up a total width of 42 feet across the roof by 616 feet long, and giving a surface of glass equal to upwards of one-third the entire area of the roof.

The roof is ventilated by means of fixed louvres, placed under the ridge skylights; these louvres consist of cast-iron standards with galvanized blades of sheet-iron fixed between them, at a sufficient angle to prevent the ingress of the rain, and at the same time to allow the steam from engines passing beneath freely to escape.

The lower ends of the "principal rafters" are formed double or forked, so as to admit the cast-iron shoe before alluded to, and through the centre of which the tie-rod passes, having a nut at the back of the shoe; one of these shoes is fixed in the wall, and the other is hung by two short links from lugs on a strong bed-plate which is fixed in the wall; the object of this arrangement being to allow for the expansion and contraction due to variations of temperature, which would otherwise throw very unfair strains on the roof and on the walls. Considering also the great length of this roof, it has been deemed advisable, in order to counteract the injurious effects arising from great variations in temperature, to break the continuous line of iron covering by making four expansion joints in the corrugated plates. This principle is also applied to the cast-iron ridge and skylight rails, which otherwise might be subject to disruption from the violent strains produced in ironwork by very high or very low temperatures.

There is a complete system of wind-ties in the roof staying the principals together diagonally.

Previous to the roof being fixed, one of the principals was put together, erected and proved under the inspection of Mr. Hawkshaw, and to his satisfaction. The dead weight with which this principal was tested was 14 tons in addition to its own weight, and with that weight is equal to 30 lb. per foot superficial upon the roof measured on plan. The principal sustained this roof without any permanent deflection. The whole of the main ties in the entire roof were proved in a proving machine, with a strain of 10 tons per sectional inch.

This roof was ordered at the latter end of September, 1849; the erection of it, together with six others, was commenced in the beginning of December following, and the whole were completed in March, 1850, with the exception of the glazing, which was not quite finished at that date.

The superiority which an iron roof possesses over one of timber is now universally admitted by engineers; and in railway roofs, more especially, are the advantages of iron experienced. Amongst its many recommendations may be mentioned the symmetry of form of which it is susceptible; the great strength that can be obtained in combination with a light and elegant appearance; its durability and freedom from all ordinary sources of decay; and the fact of its being fireproof.

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[From the London Mechanics' Magazine.]

Macintosh's Patent Lateral-Explosion, Self-Plugging Shell.

The substantial part of the invention, estimated according to its practical advantage, has received from its inventor the name of the "Lateral Explosion and Self-plugging Shell." In this missile, a simple remedy has been provided for an inherent defect in the arrangement and explosion of the ordinary shell. It is found in practice—and, indeed, the result could scarcely be otherwise—that from the want of a reacting surface at the aperture made by the shell in entering, the effort of the explosion is almost entirely wasted; producing an amount of damage quite inconsiderable in comparison with the blasting charge employed, and in many instances the shell itself being released from its bed. Of the physical energy of the explosive force, we have, probably, but very imperfect ideas, as observation seems to assign to it a far higher intensity than any other of the natural agencies we see in operation around. Among the numerous phenomena which it presents under different combinations of circumstances, none have been more satisfactorily established than this, that the violence of explosion is proportioned, probably in an increasing ratio, to the force which resists it. Thus a charge, loosely or carelessly confined, might only produce an expansive force equivalent to ten atmospheres, whereas, rigidly confined in all directions, it would be capable of exercising a power equal to 5000 atmospheres. When rendered fully effective by confinement, a small explosion will produce an amount of destructive work far exceeding that observed in less artificial arrangements. It has been pretty correctly ascertained, that a cubic inch of gunpowder is converted by ignition into 250 cubic inches of *permanent* gases, which, according to Dr. Hutton, are increased in volume eight times, at the moment of their formation by the expansive influence of heat. Assuming these data to be true, confined and ignited gunpowder will exert, at least, a force of 2000 lbs., on every square inch. Robins valued the force developed at 1000 times the pressure of the atmosphere; Euler, Lombard, and Bernouilli, at 10,000; and Count Rumford at 50,000. This great discrepancy of results shows that the experiments upon which they are based were conducted under different circumstances, and the only conclusion we are able to draw is, that the force developed is in proportion to the resistance opposed to expansion, the limit of which is not yet determined. To confine the explosion, therefore, at the moment of its generation, is the true philosophy of effective destruction of this kind, and a short explanation of Mr. Macintosh's shell will serve to show how completely and how elegantly he has complied with this condition.

Fig. 1.

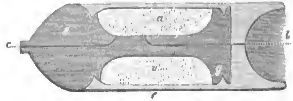


Fig. 1 is a longitudinal section through the axis of a cylindro-conoidal shell constructed upon Mr. Macintosh's principle. The dark mass of material, which occupies the centre of the shell, and which is lettered E g in the figure, represents a spindle, or solid of revolution, generated by the rotation of the dark section about its axis. In the determination of the figure of this section, a few objects are to be kept in view, of which, at present, it is only important to notice this—that it must have large recesses on either side, so as to produce a spacious annulus, or belt, the section of which is indicated by the letter *a*. It must also be provided with two grooves for the reception of an exterior casing, which is of a nature to answer at once two purposes of great utility. This casing is made of a plastic material, consisting of gutta-percha and other fusible materials, which takes with great sharpness the figure of the mould, and, when cold, possesses a uniform but flexible structure, well adapted to the purposes here contemplated. The section of the casing is shown surrounding that of the spindle, with its interior projections fitting into the grooves formed upon it. The annular space *a* is filled with the blasting charge, care being taken to ram it equally: so that it be everywhere of the same density, and that the granular condition of the powder be not impaired. To fire this blasting charge, a double provision is made. The perforation E through the mass of the spindle, communicates from *a* to the vertex *c* of the shell, which is formed into a nipple, and armed with a percussion-cap. Another perforation leads from *a* to the spherical concavity *b* in the casing, which is the receptacle for the charge.

Fig. 2.

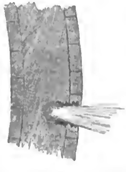
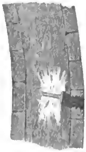


Fig. 3.



Thus constructed, and both perforations being carefully filled with slow fire, it is evident that the blasting charge deposited in *a* will be fired, either by the explosion of the cap *c*, when the shell strikes, in which case the priming-fire is conducted along the canal E to *a*, or by the ignition of the slow-fire in the groove *g*, which communicates with the propelling charge in *b*. The advantage of this construction over the ordinary shell will be readily understood. When the shell has been delivered, and has penetrated into the material against which it is aimed, the explosion of the blasting charge follows immediately without chance of failure, and the slightest consideration will show that the result must be destructive beyond any conception we have at present of exploding missiles. In these, the explosion is restrained at the aperture by the end *g* of the spindle, and can only take effect radially around it. The comparison of damage done by the ordinary shell, and by Mr. Macintosh's shell, will enable the reader to judge of the effects produced in the two cases. In the one we find a sort of cannon accidentally improvised, of which the aperture of the penetration is the muzzle, and the charge is contained in the shell. The energy of the explosion is thus expended through the aperture—the point, of all others, where it is desirable that it should not take effect. In the other we observe an opposite result. This explosion through the aperture is resisted by the expanded form of the rear of the spindle, and the gunpowder is effective without any reduction from want of reaction, in rending the material in every direction, literally, about the spindle as a centre.

That the shell should be perfect for the performance of this duty, it is important that certain conditions should be observed in its construction, some of which are conflicting in their nature; that is, one of them must be carried out at the expense, in some degree, of neglecting another. Here a maximum of general advantage must determine the combination. In the first place, the spindle of the shell must be of great strength in order to give solidity to the entire structure to enable it to overcome the resistance to penetration; and, secondly, the stem, or thin portion of the spindle, must be strong enough to extinguish the mechanical effort of that portion of the explosion which takes place within the limits of the space *a*, estimated in a direction parallel to the axis of the shell. On the other hand, by increasing the diameter of the stem for the sake of increasing its strength, care must be taken that the cavity for the blasting charge be not unnecessarily encroached upon. The section of the spindle shown in Fig. 1 approximates to the general fulfilment of objects, but the inventor has improved upon it by extending the cavity *a* towards the nipple *c*, into the head of the shell. That the spindle might possess the requisite strength, it is made of malleable iron; Low Moor iron being preferred. In consequence of the strength of the structure so created, it has a great advantage over the ordinary spherical bomb-shell; the figure of which obliges a large quantity of metal to be consumed in its construction; as it would otherwise be liable to fracture from the propelling explosion before it left the mortar. A comparison of the two, with reference to this circumstance, will show the superiority of Mackintosh's lateral-explosion shell; which is still further augmented, by relatively considering that a shell crumbles into a circle at the instant of impact.

In order that the motion of the shell through the air might be as perfect as the nature of the case seems to admit, the conoidal surface of the head of the ball is turned in a lathe; so that it may be accurately a figure of revolution. Any imperfection in this respect would produce an inequality of resistance about the axis of the shell, and vitiate the accuracy of the aim. A still further precaution is taken to insure the body being symmetrical in weight as well as in figure, with reference to its axis. For this purpose it is placed in a bath of mercury, in which it floats, the line of flotation being somewhat below the nipple. If any motion of rotation about the axis is observed, the preponderance of weight by which it is occasioned must be corrected. Thus perfect in figure and density, the aim receives full effect in practice.

Within the casing common boiler tube is employed in ordnance shells; and in smaller shells for musketry, an internal cylinder of thin sheet-iron. On the outside of the cylindrical part of the shell is a covering of greased chamois leather, the effect of which is to keep the gun clean, and at the same time to prevent windage.

It follows from the greater efficiency of this shell, that guns of smaller calibre will become equal to all purposes of action; and the inventor calculates that a six-pounder shell will produce a result of as high an order as any at present attainable. Of course, it must be understood that this missile is intended chiefly for naval action at long ranges. It would also be immensely serviceable for land operations in carrying stockades, and destroying earth-works. Against troops in the field it would be completely worthless, as its form would render it unavailable in the most destructive kind of practice, *ricochet* firing. That naval warfare, rather than military, should be facilitated by this invention, may be regarded as a fortunate circumstance. The most moderate calculation shows that on the bloody field of Waterloo only one shot in 500 killed or wounded; and a French engineer has gone so far as to assert that only one in 10,000 killed or wounded. This is probably an extravagant opinion, but naval warfare is a more serious matter. At the battle of the Nile, the *Bellerophon*, if we remember right, lost 200 men out of a crew of 750, in about fifteen minutes. An invention, therefore, which renders naval engagements more decisive, is certainly worthy of praise.

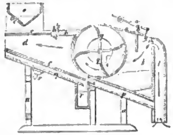
There is one application of which this shell is susceptible, and which deserves notice. In our Indian wars our troops are much harassed by the enemy's elephants. These animals carry huge baskets on their backs, which contain ten, fifteen, and sometimes thirty armed men. They are all but indestructible. As many as thirty rounds of shot will scarcely disable them; and Chuny, the celebrated elephant of Exeter-change, was not dispatched before a number of soldiers had fired about ninety shots into him. One of Mr. Macintosh's shells, exploded by the fuse leading from the propelling charge, would certainly suffice to dispatch any of these moving forts.

[From Newton's Repertory of Arts.]

Winnowing Machine. By A. V. Newton.

One of the objects accomplished by this invention is, winnowing the grain twice by means of a single fan-blower and the same current of air: the first winnowing is effected by passing the grain through the current of air discharged by the fan; and the second by passing it through the current of air entering the fan. It is stated that, by passing the grain once through this machine, it is more thoroughly cleansed than when it has been passed twice through a machine of the usual construction; although the time and labor of passing it once through this machine does not exceed that of passing it once through the ordinary machine. *a*, is the frame of the machine; a casing incloses both sides, the top, and the back end of the machine,—the front end being open, to allow the chaff and dust to pass freely out. The frame is surmounted by a hopper *c*, to receive the foul grain, which is permitted to pass gradually and regularly into the machine through an opening in its bottom; and this opening is provided with a register c^1, susceptible of adjustment, to regulate the discharge of the grain, as may be required. Below the hopper, a frame

d (which the patentee calls a shoe), is hung by four rods, one at each of its corners; and these rods are hinged at the top to the main frame, or the casing, and, at the bottom, to the lower part of the shoe. The shoe is as much narrower than the space between the two sides of the frame as is necessary to give it sufficient room to swing or vibrate from side to side, to shake the riddles and screens which it carries. The riddle e is placed near the top of the shoe, and in a horizontal position: and the screen f is placed at the bottom of the shoe, and inclined down towards the back of the machine. About the centre of the frame, and behind the shoe, a radial fan g, of the usual construction, is placed within a cylindrical shell i. The shell is shorter than the space between the sides of the frame, so as to leave a sufficient passage for air to supply the fan; and it is open at the front, to allow the blast to pass out beneath the riddle through the descending grain. A plate h extends across the opening in the front of the fan, and is hinged at its upper edge to the shell i,—its office being to give direction to the blast, which can be deflected more or less (according to circumstances) by lowering or raising the front edge of the plate by means of a cord h', that suspends it from a pin on the frame. Behind the fan there is a chamber k, from which the supply of air is drawn. This chamber is supplied with air through an upright pipe l, at the back, and through a valve m, at the top. Its bottom is inclined towards a box placed at one side,—the slope of the bottom being sufficient to cause small grain or seeds, if dropped upon it, to run down into the box; and the bottom of the box is closed by a hinged door, opening downward and kept shut by a spring, of barely sufficient strength to overcome its gravity and keep it closed. The valve m at the top of the chamber is of considerable area, and opens inward. It is held up against its seat by a weight o, acting through a lever o'. The object of this valve is to prevent variation in the speed of the fan from affecting, except within very narrow limits, the force of the current of air up the pipe l. It effects this object when the weight is so adjusted that it is about half open when the fan is running at a mean speed; for, as the speed of the fan slackens and requires a less supply of air, the downward pressure on the valve will slightly diminish, and the weight o, preponderating, will close it, so that the draft up the pipe l may not be reduced; and, when the speed of the fan increases and requires more air, the downward pressure on the valve will slightly increase, and, preponderating over the weight, will open the valve, so that the increased demand by the fan may not increase the draft up the pipe l. In consequence of this arrangement, the pipe l supplies a regular and constant quantity of air, not exceeding the minimum demand by the fan; and the complement over and above this regular supply is furnished by the valve m. Thus it will be evident, that there is no other variation in the force of the draft up the pipe l, than the slight and almost inappreciable amount required to open or close the valve. Beneath the chamber k is placed an inclined trough p, whose lower end enters the front side of the pipe l. The lower end of the screen f enters the upper end of this trough. Beneath the shoe d is placed an inclined apron or trough q, terminating at its lower end in a box r, provided with an inclined bottom, at the lower end whereof a door is placed, through which the seeds or other matters that may have accumulated in it may be withdrawn. A large band-wheel s is mounted upon a pin that projects from the side of the frame a. This wheel is fitted with a handle, whereby it is turned; and it communicates motion through a band to the fan g; the fan-shaft communicates motion to a vertical shaft, on the lower end of which there is a crank of variable throw. The wrist of the crank is linked by a connecting-rod to a pin x, on a bracket, secured to the bottom of the shoe; so that, at each revolution of the crank, the shoe d will make a double vibration or shake, the length of which will depend upon the throw of the crank at the time.



The operation of the machine is as follows:—The driving-wheel is turned, to make the fan rotate, and thus cause a draft up the pipe l, and a blast beneath the riddle, in the directions represented by the arrows; and the shoe d, with its riddle and screen, are, by the same operation, put into rapid vibratory motion. The register at the bottom of the hopper is now opened to the proper distance, to allow the foul grain to run down into the machine in such quantity as may be required. The grain, in descending, first meets the riddle, whose meshes are just large enough to allow it to pass freely through them; so that any thing larger than the grain—as heads, straws, &c.—will be intercepted and carried over the front of the machine by the blast. The grain will continue falling beneath the riddle e, until it reaches the screen f,—the blast, during its descent, blowing out the chaff, dust, and other impurities, which are deposited in front of the machine. The meshes of the screen are of such a size that they will intercept the sound grain, but will allow shrivelled grain, small extraneous seeds, sand, and heavy impurities smaller than the grain, to pass through and run down the inclined slide or trough into the box r. The grain upon the screen runs down into the trough p, and through the same into the pipe l, where it encounters an upward current or draft of air, of such strength that it will carry up with it any chaff or light grain, seeds, dust, or other light impurities that may have escaped the first blast, and will deposit them in the chamber k. The precipitation of the seeds, &c., from the current of air into the bottom of the chamber k, is greatly facilitated by a hanging partition, which deflects the current downward so suddenly as to give the particles carried in by the draft such a degree of momentum, that they are thrown without the range of the current passing to the fan, and subside into the bottom of the chamber k, which conducts them down its inclined surface into the box before mentioned. Whenever a sufficient quantity has accumulated to about half fill the box, its bottom opens by the weight, and permits the contents to run out until the weight of the quantity left is insufficient to hold the door open against the action of the spring: in this way the door opens and closes itself, so as to empty the chamber without admitting air. While the lighter substances are being thus carried up the pipe l, the sound grain descends slowly against the current, and is discharged from the pipe into a trough, measure, or other suitable receptacle beneath.

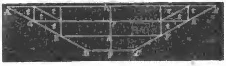
[For Appletons' Mechanics' Magazine.]

Excavation and Embankment.

BY WILLIAM ROCK, CIVIL ENGINEER, COVINGTON, KY.

No. 2.

The following investigation will show the method of calculating the corrections referred to in the preceding communication; the object being to correct the error arising by taking the cuttings corresponding to the arithmetical mean of the two end-cuttings.



Let A B C D and E F C D represent two adjacent cross-sections in a cutting; also let G H C D represent the cross-section corresponding to the arithmetical mean of the two end-cuttings.

$$\text{Let } g\,h = a, \text{ and } g\,n = b;$$

$$\text{then will } g\,p = \frac{a+b}{2}, \text{ and } n\,p = h\,p = \frac{a-b}{2}.$$

Assume $n\,p + p\,h = n\,h = a - b = d$, d being the difference in feet and decimals between any two end-cuttings whatever.

By inspecting the diagram it will at once appear that by taking an arithmetical mean-cutting, we add to the less of the two end areas the area G H F E, and we deduct from the larger of the two end areas the area A B H G; hence the excess of area excluded over that taken in is four times the triangle t, whose altitude is equal to $\frac{d}{2}$, and whose base is equal to $\frac{p}{2}$, multiplied by the ratio of side slope to unity.

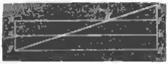
$$\text{Let } s = \text{ratio of slope};$$

$$\text{then the base of triangle } t = \frac{s\,d}{2},$$

$$\text{and the area of triangle } t = \frac{s\,d}{2} \times \frac{d}{2} \times \frac{1}{2} = \frac{s\,d^2}{8},$$

$$\text{also } 4t = \frac{s\,d^2}{8} \times 4 = \frac{4\,s\,d^2}{8} = \frac{s\,d^2}{2}.$$

The next step in the investigation is to show that the four triangles t are the bases of four equal triangular pyramids, or of two equal quadrangular pyramids, whose altitudes are each equal to half the horizontal distance between the two end-cuttings, or cross-sections A B C D and E F C D.



Let the diagram $h\,n\,g\,g'$ represent the profile or longitudinal sections of the cutting under consideration; $h\,n$ denoting the surface line, and $g\,g'$ the grade line. Now since the two lines $h\,p'$ and $p\,n$ are equal and parallel, it follows that the two lines $h\,n$ and $p\,p'$ mutually bisect each other in n; and by inspecting the two diagrams it will appear evident that the quantity $h\,p'\,n$, excluded by the arithmetical mean-cutting, exceeds the quantity $p\,n\,n$ taken in by the two quadrangular pyramids above referred to.

The area of the bases of the pyramids has already been shown to be equal to $\frac{s\,d^2}{2}$. Denote the length of station, or distance between the end areas, by l, then will $\frac{l}{2}$ = the altitude of the pyramids; and by the rule for finding the solidity of a pyramid, we have (the dimensions all being in feet)

$$\frac{s\,d^2}{2} \times \frac{l}{2} \times \frac{1}{3} = \frac{s\,l\,d^2}{12} \text{ cubic feet;}$$

we also have

$$\frac{s\,l\,d^2}{12} \times \frac{1}{27} = \frac{s\,l\,d^2}{324} \text{ cubic yards.}$$

Assume $l = 100$ feet; then

$$\frac{100\,s\,d^2}{324} = \frac{25\,s\,d^2}{81} \text{ cubic yards,} \quad . \quad . \quad . \quad (1).$$

which is the correction to be added, in order to correct the deficiency of an arithmetical mean cutting; and as it involves only the ratio of slope, the difference of the end-cuttings and a constant, it is applicable to any width of grade whatever; in other words, the corrections being computed for a given slope, they will answer for any width of grade, the width not being an element in computing the corrections.

$$\text{When } s = 1\tfrac{1}{2} \text{ to } 1, \text{ formula (1) becomes } \frac{25d^2}{54} \quad . \quad . \quad (2).$$

$$\text{When } s = 1 \text{ to } 1, \text{ we have } \quad . \quad . \quad . \quad . \quad \frac{25d^2}{81} \quad . \quad . \quad (3)$$

$$\text{When } s = \tfrac{1}{2} \text{ to } 1, \text{ we have } \quad . \quad . \quad . \quad . \quad \frac{25d^2}{162} \quad . \quad . \quad (4).$$

To test the accuracy of the formula, let the end-cuttings be 12 ft. and 22 ft., the slope $1\frac{1}{2}$ to 1, and the width of grade 20 ft.; l=100 ft. Then the arithmetical mean cutting will give

$$(17 + 8\tfrac{1}{2} + 20) \times 17 \times 100 \times \tfrac{1}{27} = 2864\tfrac{22}{27} \text{ cubic yds.}$$

We also have $22 - 12 = 10 = d$;

hence formula (2) gives

$$\frac{25 \times 100}{54} = 46\tfrac{8}{27} \text{ cubic yds.}$$

$$\text{Total quantity} = 2911\tfrac{3}{27} \text{ cubic yds.}$$

Proof by the Prismoidal Formula.

Less end area = $(12 + 6 + 20) \times 12 = 456$
Greater end area = $(22 + 11 + 20) \times 22 = 1166$
4 times the middle area $= (17 + 8\frac{1}{2} + 20) \times 4 \times 17 = 3094$

Hence we have

$$(456 + 1166 + 3094) \times 100 \times \tfrac{1}{6} \times \tfrac{1}{27} = 2911\tfrac{3}{27} \text{ cub. yds.}$$

which shows the formula to be correct.

It now remains to develop the above formula into a series by which the corrections may readily be computed by additions only. In order to do this it is necessary that d, in the formula just demonstrated, should denote the least difference of cutting recognized in practice, usually $\frac{1}{10}$ of a foot; also that it should represent the arithmetical difference by which the cuttings given in the tables increase in depth. By this notation we have the following corrections to add to the quantities found by mean-cuttings, the length of stations being 100 ft.

$$\text{For a difference} = d, \text{ add } \frac{25s}{81} \times d^2, \text{ cubic yards.}$$

$$\text{" \quad " \quad } = 2d, \text{ " } \frac{25s}{81} \times 4d^2, \text{ "}$$

$$\text{" \quad " \quad } = 3d, \text{ " } \frac{25s}{81} \times 9d^2, \text{ "}$$

$$\text{" \quad " \quad } = 4d, \text{ " } \frac{25s}{81} \times 16d^2, \text{ "}$$

$$\text{" \quad " \quad } = 5d, \text{ " } \frac{25s}{81} \times 25d^2 \text{ "}$$

&c. &c.

Assume $\frac{25s}{81} = n$, and arrange the corrections just found in the following order:

$$nd^2, \quad 4nd^2, \quad 9nd^2, \quad 16nd^2, \quad 25nd^2, \text{ \&c.}$$

Take the first from the second, the second from the third, &c., and we have the first order of differences, as follows:

$$3nd^2, \quad 5nd^2, \quad 7nd^2, \quad 9nd^2,$$

which shows that the corrections do not increase by a constant quantity. Take the first remainder from the second, the second from the third, &c., and we have the second order of differences as follows:

$$2nd^2, \quad 2nd^2, \quad 2nd^2;$$

thus we see that the differences between the corrections, arranged consecutively, form an arithmetical progression, of which the common difference is $2nd^2$, n being equal to $\frac{25s}{81}$, and d being the least difference of cutting recognized in the tables.

Let $d = \frac{1}{10}$ of a foot; then
For $s = 1\frac{1}{2}$ to 1 we have $2nd^2 = \frac{1}{108}$ cubic yard.
" $s = 1$ to 1 " $2nd^2 = \frac{1}{162}$ "
" $s = \frac{1}{2}$ to 1 " $2nd^2 = \frac{1}{324}$ "
&c.

The values of $2nd^2$, in conjunctions with their appropriate formulæ (2), (3), (4), &c., are the elements for computing the corrections under consideration. As an example, let it be required to compute the corrections for a slope of $1\frac{1}{2}$ to 1: compute directly by formula (2) the corrections for a difference in end-cutting equal to $\frac{1}{10}$ and $\frac{2}{10}$ of a foot, and take their difference thus:

$$\text{Corrections for } \tfrac{1}{10} \text{ ft.} = \frac{25}{54} \times \frac{1}{100} = \tfrac{1}{216} \text{ cub. yard.}$$

$$\text{" \quad " } \tfrac{2}{10} \text{ ft.} = \frac{25}{54} \times \frac{4}{100} = \tfrac{4}{216} \text{ \quad "}$$

$$\text{Their difference} = \tfrac{3}{216} \text{ \quad "}$$

The remaining corrections may now be computed as follows: Rule a table, and head it as in the annexed example.

Difference of cutting.	Difference of corrections. $+\frac{1}{108}=\frac{2}{216}$.	Correction in cub. yds.
$\frac{1}{10}$ ft.		$\frac{1}{216}$
0·2	$\frac{3}{216}$	$\frac{4}{216}$
0·3	$\frac{5}{216}$	$\frac{9}{216}$
0·4	$\frac{7}{216}$	$\frac{16}{216}$
0·5	$\frac{9}{216}$	$\frac{25}{216}$
0·6	$\frac{11}{216}$	$\frac{36}{216}$
0·7	$\frac{13}{216}$	$\frac{49}{216}$
0·8	$\frac{15}{216}$	$\frac{64}{216}$
0·9	$\frac{17}{216}$	$\frac{81}{216}$
1·0	$\frac{19}{216}$	$\frac{100}{216}$
1·1	$\frac{21}{216}$	$\frac{121}{216}$

By inspecting the above table it is manifest that the differences of correction increase by the addition of the constant quantity $\frac{1}{108} = \frac{2}{216}$

cubic yard. Also it is evident that the difference of correction opposite 0·2 ft. added to the corrections for 0·1 ft., gives the corrections for 0·2 ft.; and the difference of correction opposite 0·3 ft. added to the correction opposite 0·2 ft., gives the correction for 0·3 ft.; thus may the corrections for differences in end-cuttings from 0·1 ft. to 60 or 70 feet be computed in a few hours.

The corrections may be commenced by formula (1) at any difference of cutting whatever, and be continued consecutively by the series. Let it be required to commence the corrections at a difference of 10 feet.

Formula (2) gives

For a difference of 10 ft. $\frac{25}{54} \times (10^2) = 46\frac{64}{216}$ cub. yard.

" " 10·1 ft. $\frac{25}{54} \times (10{\cdot}1^2) = 47\frac{49}{216}$ "

Their difference $= \frac{201}{216}$ cub. yard.

Now by the series we have as follows:

Difference in cutting.	Difference in correction $+\frac{1}{108} = \frac{2}{216}$.	Correction in cub. yds.
10·0 ft.		$46\frac{64}{216}$
10·1	$\frac{201}{216}$	$47\frac{49}{216}$
10·2	$\frac{203}{216}$	$48\frac{36}{216}$
10·3	$\frac{205}{216}$	$49\frac{25}{216}$
10·4	$\frac{207}{216}$	$50\frac{16}{216}$
10·5	$\frac{209}{216}$	$51\frac{9}{216}$
10·6	$\frac{211}{216}$	$52\frac{4}{216}$

It may not be out of place to remark, that in computing the cubic yards as shown in this and a former communication, it is necessary, in order to avoid error, to retain the quantities in fractions, as shown in the examples. But in arranging the quantities for use, as in the following table, it is only necessary to use the nearest cubic yards.

	Width of Grade = 18 feet; Slope = 1½ to 1.										Corrections.									
Feet.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0	0	7	14	21	28	35	42	50	57	65	0	0	0	0	0	0	0	0	0	0
1	72	80	88	96	104	113	122	129	138	146	0	1	1	1	1	1	1	1	1	1
2	156	165	175	184	194	203	212	222	231	240	2	2	2	2	3	3	3	3	3	4
3	250	260	271	282	292	303	313	324	335	345	4	4	5	5	6	6	6	6	7	7
4	356	367	378	389	400	412	424	436	448	460	7	7	8	8	9	9	10	10	11	11
5	472	484	497	509	522	535	548	561	574	587	12	12	13	13	14	14	14	15	16	16
6	600	614	627	640	654	668	682	696	710	725	17	17	18	19	19	20	21	21	22	22
7	739	753	768	783	798	813	828	843	858	873	23	23	24	25	25	26	26	27	28	29
8	889	904	920	936	952	968	984	1000	1017	1033	30	30	31	31	32	33	34	34	35	36
9	1050	1066	1083	1100	1117	1134	1151	1179	1196	1214	37	38	39	40	41	42	43	43	44	45
10	1222	1240	1258	1276	1294	1312	1330	1349	1367	1386	46	47	48	49	50	51	52	53	54	55
11	1405	1424	1443	1462	1482	1501	1520	1540	1560	1580	56	57	58	59	60	61	62	63	64	66
12	1600	1620	1640	1660	1681	1701	1722	1742	1763	1784	67	68	69	70	71	72	73	74	76	77
13	1805	1826	1848	1869	1890	1912	1934	1956	1978	2000	78	79	80	81	83	84	85	86	87	89
14	2022	2044	2067	2089	2112	2135	2158	2181	2204	2227	91	92	93	94	96	97	98	100	101	103
15	2250	2273	2297	2320	2344	2368	2392	2416	2440	2469	104	105	107	108	110	111	112	114	115	117

In the above table the depths of cutting in feet are placed in the left-hand column, which answers both for the mean-cuttings and the corrections, and the tenths are placed across the tops of both tables.

To use the above tables, take the arithmetical mean, and also the difference between the end-cuttings; then in the table of quantities look opposite the feet and under the tenths for the cubic yards corresponding to the mean-cutting; and for the correction look opposite the feet and under the tenths corresponding to the difference of the end-cuttings. The sum of the two quantities thus found is the quantity required for a hundred-feet station, and for a cutting less than a hundred feet long a correct proportional part must be taken.

Example 1.

The end-cuttings of a station 100 feet long are 12·6 feet and 8·8 feet. Required the cubic yards by the table.

$\frac{12{\cdot}6 + 8{\cdot}8}{2} = 10{\cdot}7$ - - 1349 cub. yards.

$12{\cdot}6 - 8{\cdot}8 =$ 3·8 correction 7 "

Total quantity 1356 "

Example 2.

Two end-cuttings 80 feet apart are 20·4 feet and 6·8 feet deep. Required the cubic yards.

$\frac{20{\cdot}4 + 6{\cdot}8}{2} = 13{\cdot}6$, per table we have 1934 cub. yds.

$20{\cdot}4 - 6{\cdot}8 = 13{\cdot}6$ " correction, 85 "

Total in 100 feet = 2019 "

And $2019 \times \frac{80}{100} = 1615\frac{1}{5}$ cub. yds.

In subsequent communications it will be shown how every variety of irregular cross-sections met with in railway excavations and embankments, may be expeditiously reduced to trapezoids, and equivalent cuttings be used for finding the cubic yards from tables constructed as above. It will also be shown that the results obtained by changing irregular solids into equivalent regular ones, are equally as much to be depended upon for final estimates, as is the method recommended by some engineers, of resolving the solids into their elementary geometrical figures, and that it is attended with far less labor.

Wm. Rock, C. E.

Covington, Ky., Feb. 26, 1853.

Outlines of the Science of Mechanics.

No. 2.—Simple Forces.

Meaning of the various common terms employed—Additional terms proposed.

Teacher. I have supposed you to already have some general knowledge of the first principles of Natural Philosophy and to be familiar with the common terms employed, such as Inertia, Friction, Space, Time, Velocity, Mass, Matter, Volume, Cohesion, Hardness, Adhesion, Elasticity, &c., am I correct?

Pupil. I have a general acquaintance with those terms, and think I know their meaning, though not as fully and definitely as I might.

Space and time are each too apparent to demand much definition, and the velocity of any object is equally so. Matter I consider synonymous with substance, stuff, or material, and by the mass of any given body or object I understand the quantity of matter therein, so that if two masses are equal, I suppose them to weigh the same when weighed under the same circumstances, though their bulk or volume may differ.

T. Right. All these terms might be examined much deeper, but it is not necessary at present. What do you understand by Inertia?

P. That property in matter which resists any change with regard to motion or rest. Every mass in motion tends to continue on in a straight line, every mass at rest tends to continue so forever unless acted on by some force.

Inertia is displayed in every case in which the motion of matter is changed. If a force acts on a mass to give it motion or to increase its motion, inertia resists and holds back; if a force tends to decrease or stop the motion, inertia helps to continue it; and if a force tends to divert or change the direction of the motion, inertia displays itself as a force tending to resist such change.

T. Correct. Do you know the meaning of the word friction?

P. None can well avoid a knowledge of friction. It is the resistance which is always experienced to rubbing. No two masses can rub against each other without producing friction. Solids, fluids, and gases, are all subject to friction whenever there is rubbing of the particles against each other or against any other mass. Heat is produced by friction, but whether it is produced by it in all cases, and whether it is proportional in all cases to the friction, I cannot say. Fats and oils when present on the rubbing surfaces, diminish friction, so does water and steam; but how, I cannot exactly say, further than that these lubricators are supposed to fill the cavities and make the surfaces rub more even and polished.

T. Very well. What is cohesion?

P. It is the force by which the minute particles of any mass are held together. All matter is supposed to be composed of very minute particles. In some solids the cohesion is slight, as in chalk or clay, and the particles separate when acted on by a slight force; in others it is much stronger, as in wood, iron, &c.

T. What is adhesion?

P. It is a sticking property possessed by some substances. When one mass sticks to another we term it adhesion, but I cannot well distinguish in all cases between *ad*hesion and *co*hesion. This bit of paper coheres together; now I tear it, the force with which I pull is the force necessary to overcome the cohesion of its particles; now I wet it and place it on the wall of the room, and it sticks there with a slight degree of force; it adheres to the wall. The force with which it adheres to the wall grows less as it dries, till it becoming less than that of gravity, the paper falls to the floor. Now I put glue on the paper and again it adheres to the wall, but this time, as it dries, the adhesion becomes greater, till at length it is greater than the cohesion of the paper, and the paper splits when I attempt to separate it. These bricks, when first laid, were held together only by the *ad*hesion, but now we call it the *co*hesion of the mortar. I am unable to say exactly when it changed, or how to precisely define the difference between the two terms.

T. Important as it is to attach a distinct meaning to every term in Mechanics, I anticipate no confusion from an illy-defined distinction between these. They are sufficiently plain for our present purpose.

P. You have spoken of solids, liquids, and gases; I have a tolerable idea of these, but not perfectly definite. I am told that all matter exists in one or the other of these forms, and that all substances are supposed to be changeable by heat in these respects, &c.; cast-iron, at ordinary temperatures, is solid; by this is not meant that it is free from pores and cavities, but that it is hard and fixed in its shape. Iron may be melted by a high degree of heat, and it then becomes a liquid. Ice is a solid, water a fluid, and steam a gas, though each is so only for the time being, and may be changed into the other forms by raising or lowering the temperature sufficiently. Now there are certain substances which I find it difficult to class, which are soft and capable of being changed with facility into other forms, yet do not readily assume a perfect level, &c. How shall we class mud, lava, &c., in certain conditions?

T. There are few perfect examples of these three classes, or rather there are many imperfect ones. Many substances partake more or less of two or all these forms. In fact, "semi-fluid" is a term in frequent use, and many branches of art depend on so arranging the circumstances as to induce conditions approaching more or less to the state both of a solid and a fluid. Plaster is worked in this state, so is solder, and so is the clay of the potter and the brick-maker. So also is the heated iron on the anvil. A perfect solid would be perfectly hard, a perfect liquid would be perfectly limpid and possess no cohesion or adhesion, yet there are few if any examples of perfection in these respects. Gases are tolerably perfect, the whole range of gases being elastic to a degree very near perfection, and subject to but little adhesion or friction. You have very properly considered steam a gas so far as its mechanical properties are concerned. Permanent gases are those which have never yet been condensed into a liquid or solid, though it is considered theoretically possible thus to change them. Steam is not a permanent gas, because it is readily condensed to water, either by abstracting its heat or by compressing it into a smaller space. Carbonic acid gas is not a permanent gas for the same reasons.

We have now proceeded in our examination of Force so far as to obtain a *definite* idea of one of its usual meanings, and *the* meaning which I wish always attached to it in our future conversations. Let me hear you explain what you know about simple force.

P. Force is any thing pulling or pushing in any direction. Its amount or intensity may be expressed in tons, pounds, ounces, or the like. Forces are sometimes constant, sometimes variable, depending on the nature of the agent exerting the force, and on the nature of the resistance opposed to it. A force which does not produce motion is called a static force; one which does produce motion is called a dynamic force; and one which destroys motion, such, for example, as that with which a horse holds back on descending a hill, is called ——. You have not given any term to apply to that case, though there must be many such cases, and those very important ones to be considered. You have said, however, that machinery is full of examples of *latent forces*, so to speak, existing in various parts ready to act when called upon. You spoke of them as *pounds* or *units* of *strength* or *force*, will you now explain a little further on this point?

T. I refer to the forces exerted in various directions by the cohesion or hardness of the parts of material structures, and particularly of machinery. The forces to which I allude, and which on your suggestion we will term "latent" forces, are those which come in play in the character either of resistances or of lateral forces, and are exerted in resisting or changing motion. And here notice this important fact of which writers on Mechanics have taken little or no notice, viz:—static force may and does change the direction of motion in a moving mass. I have explained that a force which produces motion is a dynamic force, and a force acting against a fixed object is a static force; what I now add is, that an agent may act laterally or side-wise on an object in motion and change its direction without being itself affected in the least. I term this also a static force. I would thus classify three different circumstances under which forces may act. 1st, Dynamic, in which motion is produced. 2d, Static, in which motion is not produced, though it may be changed in its direction; and 3d, a condition for which there is yet no definite name, but which we will call *Re*-namic, in which motion is retarded or destroyed, this name being retained only till a better is procured.

P. You term it *re*-namic from resistance, reaction, and similar terms perhaps, which are already in use, although with too confused and multitudinous definitions to answer our purpose.

T. Yes. A force displayed under these circumstances is, in some sort, the reproduction, or reflection of a dynamic force. The Renamic forces are the conservative forces of the natural world. Friction is invariably a renamic force; it destroys, absorbs, annihilates, or consumes motion.

P. We have now two new terms not used in the text books, viz: Latent Force and Renamic Force; let me see if I can explain them. Latent forces are the force of cohesion, &c., of the different parts which are developed in quantities, and in directions, proportioned to the strain. Renamic forces are resistances of any kind which are being overcome. If a resistance is not in the act of being overcome, it is neither Dynamic or Renamic, it is Static.

T. Very good. Now let me hear you apply all the terms properly to some familiar case; for example, the action of a water-wheel.

P. Suppose it be an ordinary breast wheel, receiving the water into buckets at the circumference, which actuates the wheel by its weight. The gate being opened, the water flows through and fills the buckets until the weight is sufficient to overcome the resistance and impart motion to the wheel. The gravity of the water in the buckets which until now had been a static force becomes suddenly dynamic. More water continues to pour in, and other buckets are successively filled, so that that side of the wheel is permanently heavier than the other, and the motion is continued. Gravity impels the water and with it the bucket in a vertical line downward, but the cohesive strength of the wheel compels it to conform to a circular motion and assume a curved line of descent. This cohesive strength is a latent force which thus comes in play, and is further useful in transmitting the force of the weight to the geered segments and through them to the other mechanism of the mill. The static force thus developed in the cohesion of the parts, &c., may be much greater than the original dynamic force of the water descending in the buckets.

The mill is now fairly and evenly in motion. Each bucket as it reaches a point near its lowest position, empties itself and ascends on the other side empty, or nearly so. A small quantity of water remains which is carried up dripping and trickling down, or trying to do so, along the outside of the buckets. The weight of this water, as also that of the buckets and the whole of the ascending half of the wheel, exerts a *renamic* force on the motion of the mill tending to hinder it, while all the weight of the half of the wheel as well as the water on the loaded side, is dynamic, or tends to increase it. The surplus force of the loaded over that of the unloaded side is what impels the machinery. The inertia of the wheel is either dynamic or renamic, according as the velocity of the wheel, at the instant, be diminishing or increasing. If the motion is smooth and equable the inertia of the wheel is not felt at all.

T. Very good. We will soon proceed to examine the relations of Force, Space, Time, &c., and the production of Power or Work.

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LIST OF PATENTS,

Issued from the U. S. Patent Office during the month of March, 1853.

Seth Adams, of Boston, Mass., for Improvement in Printing Presses.

Claim.—I claim, first, the combination of the vibrating platen with the sheet-holders, arranged as specified, so as to be kept up a little distance from the platen when in position to receive the sheet, and moving with said platen to the form, in order to hold the sheets thereon and draw them from the types, also with the gages for registering the sheets.

Second, the mode of keeping the sheet-holders up from the platen when the sheet is to be placed. Said means consisting of an arm on each end of the rod (on which said holders are fixed, and with which they turn), and stops, against which said arms strike, the arrangements and operation being substantially as set forth.

Third, the apparatus for delivering or taking off the sheet from the platen after it is printed, consisting of the moving or sliding tympan-cloth, in combination with the turning segment, to which an intermittent and reciprocating rotary motion is imparted by the catch, ratchet, and spiral spring, operating as specified.

Henry Bessemer, of Baxter House, England, for improvement in Cane-Juice Evaporators.

Claim.—I claim the combination of a hollow and perforated shaft, connected with an air-blast apparatus, a series of plates, or a screw plate (placed around and on the shaft), a reservoir, trough, or basin, for holding the liquor to be evaporated.

Also, the combination of a hot-water vessel and its heating apparatus, the cistern for holding the saccharine liquor, and the apparatus for effecting its evaporation by means of hot air blown on thin or extended surfaces, a screw or plates, as specified.

Henry Bessemer, of Baxter House, England, for improvement in Filters for Cane Juice.

Claim.—I claim the combination of the receiving vessel, rotating filtering drum (placed within the said vessel), gutters (within the drum), the hollow axle or shaft (connected with said gutters), and the scraper applied to the outer surface of the revolving drum, the whole being arranged and made to operate together, substantially as specified.

S. A. Clemens, of Springfield, Mass., for improvement in Breaking and Dressing Flax.

Claim.—I do not claim simply the double action of beaters, as that is well known in a great variety of machines for various purposes.

What I claim is the method of breaking and dressing flax or other fibrous substances, by a beater constructed in the manner described (vibrating on a central axis), between the faces of which the flax, &c., pass as described, when this is combined with one or two pairs of rests placed in close proximity to the edges of the beaters between which the flax passes, as specified.

Also, in combination with the beater and rests for breaking and dressing, as described, the employment of a pair of rollers, each of which is grooved in the direction of its periphery, and one of which is made to vibrate in the direction of its axle, for the purpose of opening and softening the fibres, as described.

Samuel Gardiner, of New York, N. Y., for improvement in Magnetic Machine for Washing and Separating Gold.

Claim.—I do not claim to have invented a rotary cylinder of magnets, for the purpose of separating magnetic particles from ores or metals; but I claim separating gold or other metal from earthy and magnetic particles, by means of a rotary cylinder of magnets, which magnets, at the same time as they collect the magnetic particles, serve as agitators for agitating the water and the metal and earthy and other foreign matter which is mixed, for the purpose of washing away the said earthy and other foreign matter, the said cylinder of magnets being constructed and arranged in relation to the trough containing the aforesaid mixture in any way, substantially as set forth.

J. F. Mascher, of Philadelphia, Pa., for improvement in Daguerreotype Cases.

Claim.—I do not claim the invention of a stereoscope, for that has been previously discovered; but I claim constructing a daguerreotype case with an adjustable flap or supplementary lid, said flap or lid being within the case, and having two ordinary lenses placed in it; by which, upon adjusting the flap or lid, a stereoscope is formed of the case, and the two daguerreotypes, by binocular vision, are apparently formed into a life-like figure.

L. A. Orcutt, of Albany, N. Y., for improvement in Moulding in Flasks.

Claim.—I claim, in combination with a flask having a continuous or reciprocating rotary motion, the rammer or rammers, so arranged as to be made, at any time during their operation, to work in any portion of the flask, whilst, at the same time, they have an automatic adjustment, so as to rise as the flask is filled and rammed, and adjust themselves vertically in regard to the flask, the whole being accomplished as described.

Thaddeus A. Smith, of Albany, N. Y., for improvement in Moulding for Cast-Iron Plates.

Claim.—I claim the process of moulding the recesses in the tops of stove plates intended for the reception of the lifters, by which such plates are handled (which recesses are required to be dovetailed), by employing pattern cups shaped to form such recesses, divided by a vertical cut into two parts, so that the said cups can be removed from the core formed by them, by moving each division of it horizontally from the core, before raising it off the sand, and by fitting the cup pattern into the pattern of the stove plate, so that the plate pattern can be lifted from the sand, leaving the cup behind it, as set forth.

Joel Tiffany, of Cleveland, Ohio, for improvement in Machines for Dressing Shingles.

Claim.—I claim the combination of parts consisting of the pinions, with the intermediate geers. The levers and joint levers and sections, with the connecting-rods and cam, for the purpose of operating the arm, as described, turning and removing shingles, at the same time, from one side of a reciprocating bed to the other, and then, when its second face is dressed, throwing it from the machine in a finished state.

John A. Wagener, of Charleston, S. C., for improvement in Cannon Sight.

Claim.—I claim the sighting apparatus, consisting of the corresponding pendula, as described, hung between the graduated side-pieces or uprights, in connection with the protecting and regulating slide, with its rifle sights, said pendula having free sway, by means of the rotary mounting of the uprights and upper part of the apparatus on the screws and pivots, and the whole being attached and shifted into horizontal position on the cannon by means of the movable spring-clasps, all constructed and combined as set forth.

Warren Aldrich, of Lowell, Mass., for improvement in Turning Lathes.

Claim.—I claim, first, the improvement described, which consists in giving an automatic motion to the upper slide or tool rest, when set at any angle to the bed-piece of the lathe, instead of moving it by hand, so as to turn with ease and accuracy solid or hollow cones, as set forth, by means, substantially, of the screw, revolving worm shaft, and revolving plate, as set forth.

Henry Bessemer, of Baxter House, England, for improvement in Machine for Expressing Cane Juice. Patented in England, February 24, 1852.

Claim.—I claim the improvement of constructing each of the cane-pressing tubes, substantially as specified, viz., with sides made parallel some distance (for the working of the piston against), and to approach one another towards the mouth of discharge of the pressed cane, whereby advantages as mentioned are gained.

Also, the combination and arrangement of the compressers, or pressing tubes, and two conjoined pistons, with one revolving, actuating shaft, and its mechanism, to give to their plungers or pistons a simultaneous reciprocating rectilinear motion, all as mentioned.

Henry Bessemer, of Baxter House, England, for improvement in Heaters for Sugar Syrup. Patented in England, February 21, 1852.

Claim.—I am aware that in locomotive engines water has been heated by standing in tubes exposed to the flame or direct heat of a furnace; now such a mode of heating will not answer for the treatment of the saccharine syrup, as the heat of a furnace is not susceptible of regulation, as is that from steam, the latter not burning the syrup, or injuriously heating it, as would the former.

I have discovered that the heat of steam applied to syrups, as described, in connection with the action of gravity, produces advantages, in rapidly heating the syrup, unattainable by any process when the syrup is passed through pipes heated by direct heat, or the flame of a furnace.

It is, therefore, that I expressly disclaim the mode of heating water by allowing it to flow through a stand or tube heated by the direct heat of a furnace, but base my invention on the method described of treating saccharine syrup, by means of the apparatus represented, as arranged and constructed to operate for the purpose set forth, by the power of gravity and steam, the same consisting of a combination of the receiving vessel, series of tubes, a chamber and pipe, and the steam chamber, having induction and eduction pipes, as specified.

Wm. & S. G. Coleman, of Providence, R. I., for Topping-lift and Peak-halyard Block of Sail-Vessels.

Claim.—We claim supporting the topping-lift by means of a crane, of such form and construction that when the topping-lift sags, when the sail is hoisted, it shall not foul or chafe against the peak-halyard block.

Also, so arranging and constructing such crane, that it may also support the peak-halyard block, as specified.

Peter Ten Eyck, of New York, N. Y., for improvement in Rocking-Chairs.

Claim.—I claim in combination with a sitting chair, so arranged that the seat may rock upon the legs, or support the safety-piece or guard, hung eccentrically to the pivot of the bar on which it rests, and the spring for preventing the top part of the chair from rocking too far or too suddenly, as described.

Moses Marshall (assignor to W. Aldrich & L. B. Tyng), of Lowell, Mass., for Improvement in Knitting Machines.

Claim.—I claim, first, connecting the rotary depressers and the feeder, which carries the thread, with the arm which connects the reciprocating cam bores, as described.

Second, dividing the plates which support the needles and cast the stitches at the angle of intersection of the two sets of needles, so that the fabric knit will or may pass between them.

Third, forming the stitches alternately on each side of the needle-rests, by two sets of needles, placed at an angle to each other, and operating one needle at a time, as set forth.

H. N. Black, of Philadelphia, Pa., for Hydraulic Steam-Pump.

Claim.—I do not claim a double-cylinder pump or water engine, nor opening a valve at the end of the stroke of a steam-piston, and injecting water into a steam-cylinder, for producing a partial vacuum; but I claim the combination of the double-slotted water and steam cylinder, double pistons, and slotted piston-rod, arranged and operating in the manner set forth.

J. P. Comly, of Dayton, Ohio, for Machine for Separating Paper by Single Sheets.

Claim.—I claim, first, a table or range of tubes, connecting with an exhaust-pump or vacuum, for separating the edge of a sheet from a heap of paper, by atmospheric pressure, in combination with a roller, or its equivalent, traversing to and fro on the upper sheet, for the several purposes of lowering and admitting air between the leaves, presenting the edge of the top sheet to the tubes, and, on its backward stroke, serving to straighten the pile.

Second, the tube or tubes aforesaid, in combination with the vibrating supporting-bar, for upholding the forward edge of the sheet when dropped by the tubes, presenting it properly to the fingers, and supporting it from the heap, while being drawn away.

Roswell Enos and Bela T. Hunt, of St. Charles, Ill., for Improvement in Tanning.

Claim.—We claim the process of tanning with the use of lime, salt, bran, sumac, and cutch, or any other tanning in room of cutch, substantially in the manner described, whereby we commence tanning at the same time that we commence reducing, as the salt and bran overpowers the lime, the tan takes the place of the lime, and converts the hide into more perfect leather, and in less time than can be made in any other way.

Hides are not liable to get damaged by our process, as we do not use an article that is injurious to leather.

It is not on the materials used that we claim letters-patent, but on the manner of applying them to the hide, as set forth.

Mills A. Hackley of Belleville, N. Y., for improvement in Cheese Presses.

Claim.—I claim the turning-table, or its equivalent, in combination with the roller, in such manner, that whenever the table is adjusted for turning the cheese, there will be a corresponding adjustment of the roller for facilitating the process of turning the same.

Wm. Mansfield, of Dracut, Mass., for Improvement in Knitting Machines.

Claim.—I claim forming the loops, in knitting ribbed fabrics, by the combination of two sets of needles, made to operate together, as set forth, the same enabling me to give important advantages in the construction and operation of the loom.

James Riley and William Allen, of Southfield, N. Y., for Improvement in Distilling Rosin Oil.

Claim.—We claim the process by which we manufacture oil from rosin, by passing it from an alembic, through expanding worms, or their equivalents, surrounded by a jacket of fire-brick or clay, whereby we prevent destructive distillation, carbonization, and greatly economize time, as set forth.

James Stanbrough, of Newark, N. J., for improvement in the Manufacture of Harness.

Claim.—I claim the forming of rounds, raises, or rolls, on the different parts of a harness or other leather work, by doubling and stitching together a strap of leather, at its edges, and then binding these edges by a separate piece, and connecting the stitching of such binding by drawing up and fastening by the side thereof folds of the strap; and this I claim, whether the single strap only be used for forming a single roll, or a secondary strap be used for forming two or more rolls, as described.

Seth D. Tripp, of Rochester, Mass. (assignor to E. L. Norfolk, of Salem, Mass.), for Machine for Pegging Boots and Shoes.

Claim.—I claim the combination of each frame, with its supporting shaft, by means of a rocker-frame, the same being for the purpose of allowing a free vertical as well as other movements, as described, by either of the frames, so that it may be guided, in its vertical movement, by the curvature of the upper surface of the sole of the boot or shoe, and horizontally by the cam-wheel, substantially as specified.

Also the manner of combining the awl and driver with one carrier, made to operate as described, whereby they are alternately presented or brought down against or towards the sole, by the revolution of the carrier, as specified.

Also the combination of the guide with the knife or chisel, and so as to operate therewith, in the manner and for the purpose of guiding said chisel properly against the peg-wood, as described.

Also the improvement in the construction of the charger, viz., the making of the same with two or more separate compartments for holding the strips of peg-wood, which compartments are to be successively brought forwards under the operation of the piston-slide, as the several pieces or strips of peg-wood are successively cut up into pegs, meaning to claim a combination of a series of compartments, in the one single piston slide, made to operate as set forth.

Also the combination of mechanism by which the charger is moved, the same consisting in the operating spring, rack, click or pawl, and spring, applied to the upright part of the pawl, the whole to act in conjunction with the piston-slide, as described.

Also the combination of mechanism for operating the slide, the same consisting of the rack or ratchet thereof, impelling pawl, spring-lever, cam, ratchet-wheel, and spring-hook pawl, as applied to the frame and the bar, and made to operate substantially as set forth; the same causing peg-wood to be shoved through the charger, and keeping the pegs in advance of the peg-wood, and successively forcing them into the correct position over the hole made in the sole by the awl.

And, in combination with the pressure-spring, I claim the lever, with its bent projection, spring, bent lever, and cam, the same being for the purpose as set forth.

Luther Atwood, of Boston, Mass., for Improvement in Lubricating Oils.

Claim.—I claim the manufacture or combination of paranaphthaline and fixed oils derived from coal tar, and boiling from 450° to 675°, Fahr., as produced by the process, as described; the said new manufacture being highly useful as a lubricating composition, either alone or combined with oils or fatty matter as set forth.

Also the combination of this product so made with concrete, or thick fatty matter, or oils, for the purpose of liquefying them, or rendering them more mobile, or imparting to them lubricating qualities, as specified.

S. Briggs and J. G. Talbot, of Sloansville, N. Y., for Improvement in Winnowers of Grain.

Claim.—We claim causing the upper sieve or riddle to vibrate at a greater speed than the screens, as set forth.

Lewis W. Colver, of Louisville, Ky., for Improvement in Breaking Hemp.

Claim.—I claim the combination of the oscillating beaters, and the spring-bars placed above and below the beaters, so that the recoil of the springs, after the beater leaves the bars, shall shake out the hemp and clear it of its woody portions, as described.

Wm. Ennis, of New York, N. Y., for Improvement in Hot-Air Furnaces.

Claim.—I claim the employment of an inverted cone within a drum or cylinder, in whose side the taper end of said cone is inserted, and allowed to communicate with the surrounding atmosphere, for the purpose of creating an atmospheric reversing draft to cool the direct heated current from the fire; the said cylinder communicating with the fire-chamber and ash-pit, as described.

Moses G. Farmer, of Salem, Mass., for Improvement in Electric Telegraphs.

Claim.—I claim the method, as described, of bringing any number of telegraphic signalizing and recording instruments into successive electric connection with the common communicating wire; meaning, more particularly, to claim the combination of the writing and working, or primary and secondary circuits, the electro-magnets and movable armatures of the primary circuits, the local magnets and their movable armatures and pallets, or equivalents therefor, and local battery and battery connections of each terminus, and connections leading to the armatures of the local magnet, the escapement wheels and wheels U and Z on the arbor of each, the two series of springs of said wheels U and Z, and branch connections of the main writing-circuit at its two termini, the whole being connected and made to operate together, as described.

Benj. Fenn, of Hartford, Ohio, for Improvement in Pendulum Balance.

Claim.—I claim a machine for ascertaining, instantly, the weight of bodies by means of a scale, dish, or plate, supported by pivots upon a heavy-weighted semicircular frame, or its equivalent, in the manner of a pendulum, and operated by catches, as described.

Isaac H. Garretson, of Clay, Iowa, for improvement in Seed-Planters.

Claim.—I claim planting corn in check rows, by the planting sides, worked on the cross-bar by hand, in the manner set forth.

John Maxwell, of Galesville, N. Y., for improvement in Knitting Machines.

Claim.—I claim the construction of the locking apparatus, by placing standards upon the back ends of the half jacks, to carry springs, which regulate the pressure of the bar upon the jacks, in combination with an apparatus for raising said locking-bar, the whole constructed and arranged for the purpose as set forth.

Thomas McAdams, of Boston, Mass., for Improvement in Paging Bound Books.

Claim.—I claim the employment of a square rotating shaft, as a bed for the odd numbers, and the shaft D as a bed for the even numbers of the types, in combination with the tongue, as a platen to both sets of types, the same being operated by the treadle ratchets and pawls, so as to enable the operator to print the odd and even numbers of the alternate pages of a bound book, by a single movement of the treadle, as described.

James H. Swett of Boston, Mass., for improvement in Spike Machines.

Claim.—I claim skewing the shafts or axes of rotary pointing dies, so that they shall stand oblique to each other, and bevelling off the faces of the dies to the same, or about the same angle at which the shafts stand to cross each other, for the purpose of forming a close-fitting space in front of the dies, or where the blank is fed in, and spreading the dies in rear or behind, where the spike is pointed, so as to release it and allow the nippers to take the spike from the pointing dies, without injury to the spike, as described.

George Traeyser, of Cincinnati, Ohio, for improvement in Vertical Pianos.

Claim.—I claim the construction, as described, of a vertical piano, having the tuning-pins placed below the lower edge of the sounding-board, for the objects explained.

Thomas C. Thompson, of Ithaca, N. Y., for improvement in Sewing Machines.

Claim.—I claim, first, the magnetic shuttle-race, one or both, for the purpose of keeping the shuttle in perfect contact with the face of the shuttle-race, without the use of springs or any other device, and thereby insuring the securing of every stitch, as described.

Also, the curved and hinged cap, in combination with the shuttle, to confine the cop in the shuttle, as set forth.

Also, the use of a cop, without spindle or spooler, in combination with a shuttle, or its equivalent, when the thread is drawn from the inside of the cop, by which means I retain a uniform draught on the cop-thread as it is drawn or paid out from the shuttle, as described.

Matthew Walker, Matthew Walker, Jr., and D. S. Walker, of Philadelphia, Pa., for improvement in Wire Fences.

Claim.—We claim the arrangement of the hooks within the mortises, so that the parts of the hook shall be sustained and kept from spreading by the mortise, and a strain upon the wires tend to steady the posts, as described.

RE-ISSUES.

Adam Hays, of Pittsburg, Pa., for improvement in Splints for Fractures.

Claim.—I claim the cutting out a portion of the splint, to afford an opportunity for dressing as often as may be necessary, the upper and lower portions of the splint being kept firmly united by means of the brace, so as, by extension and counter-extension, to keep throughout the treatment the proper relative position of the parts concerned, the slide being replaced after each dressing, or any other device substantially the same.

Wanton Rouse, of Taunton, Mass., for improvement in Self-Acting Mules for Spinning. Patented originally Nov. 2, 1852.

Claim.—I claim, first, governing the revolution of the spindles in winding the yarn on the cop, also in backing off during the progressive stages of the building, by means of a cam or any equivalent device of irregular form, circumferentially with the said irregularity, varying from end to end; the said cam or equivalent being caused to operate upon the mechanism which drives the spindles, in any way that will produce the results set forth.

Second, the mechanism for causing the finger through which the irregular surface of the cam or its equivalent acts upon the mechanism which drives the spindles, in backing off and building on, to traverse the said cam, and to be kept close to its surface, consisting of the screws, nut, cord or chain, lever, and stud, operating in combination, as set forth.

Thomas J. Sloan, of New York, N. Y., for improvement in Screw Blanks.

Claim.—I claim the lifters, which select and lift the blanks, &c., from the hopper, substantially as specified, in combination with ways or conductors, or the equivalent thereof, as specified, into or on to which the blanks, &c., are transferred.

Also, giving to the lifters or to the inclined ways, or their equivalents, a lateral motion, in combination with a stop or detector, as specified, for the purpose of arresting the operation of the lifters until a further supply is required.

Also, the sliding carrier, with its recess, for receiving and holding the screw blanks, as specified, in combination with the spring-fingers, for taking the screw blanks from the carrier, and presenting them to the jaws as specified.

The Caloric Engine.

In what respects is the great experiment of 1852–3 a triumph? in what respects is it a failure? Probably no ship has been constructed in modern times which has attracted more attention, and from the performance of which more decisive and important results have been expected, than from the caloric ship Ericsson. The experiment has been as yet, strictly speaking, undecisive, but we consider it substantially a failure. The extraordinary anticipations of the mass, and the hopes or the fears of the mechanic, have been yet unrealized. Many are deeply and peculiarily interested in the question of its success or failure. Thousands of men are now living in easy and careless circumstances, supporting a family in a tolerably liberal and expensive style, whose whole capital is thorough and long experience in the manufactore and use of steam. Thousands of others are relying for wealth on their established business, and their facilities for the manufacture of peculiar styles of engines, boilers, tubes, gages, valves, cocks, regulators, felting, hydrostats, salinometers, condensers, refrigerators, and the various *et ceteras* of steam-engineering. Other more enterprising men would hail any revolution as a god-send; and the whole world are directly or indirectly interested in any device which shall perform the work of the steam-engine better or cheaper. The caloric ship has now been several months in service; —has its performance established any facts?

In the absence of favorable opportunities for information, we must continue, as heretofore, to approximate as near as may be to the actual condition and results of the experiment. The ship is now lying quietly at her dock in Williamsburg. The templates are shaped for the new heaters, or bottoms of the cylinders, and their construction is ready to be commenced on, should the proprietors of the ship deem it expedient to continue the experiment longer. Fickle public opinion seems somewhat wavering with regard to its merits. A few daily and weekly papers (a tolerable index of the general sentiment of the community) have copied the letter of Capt. Ericsson, in our last number without comment, but the great majority maintain a profound and ominous silence. The stationary engine for the Evening Post establishment is nearly completed, having been already in operation, experimentally, in the shop. This engine is composed of two single-acting engines, essentially similar in principle and form to those of the ship. The reservoir, however, encircles the furnace in such a manner as to economize the radiant heat which would otherwise escape. Of the progress of the various caloric navigation companies which were, a few months since, reported as soliciting the legislatures of several States for acts of incorporation, we know nothing.

The above is probably correct, so far as it goes. Our query with regard to the blowing passages being open or closed on the trial trips has been answered since our last issue. The passages were closed.

The Ericsson has been two trips down the harbor and one to Washington, or vicinity. The forced draught was not used on these trips. "More than seven miles per hour" has been obtained by a consumption of four and a half tons of coal per twenty-four hours; the average speed on the sea voyages, between New York and the Potomac, was, we think, from three to five miles per hour. On leaving Alexandria on the 6th of March, in a dead calm, the engines of the caloric ship made as much as nine turns a minute, Acquia Creek, on the Potomac, being reached in four and a half hours, the forced-draught passages having been previously closed with brick-work. The engines have performed regularly and smoothly in a heavy sea, and have shown themselves to have been sufficiently braced in the ship.

All this is claimed, and probably with justice, as among the results of the experiment, yet, aside from the practical difficulties in the details, which may, perhaps, yet be removed, the main object of the experiment remains unaccomplished. That object is to supply the place of the steam-engine in navigation. Thus far it has proved itself open to its chief objections, without its advantages. The steam apparatus is costly, heavy, cumbersome to manage and keep in repair, it occupies a large portion of valuable space in a vessel, and involves a great expense in consumption of fuel, &c. The caloric engine is open to all these objections to a greater or less degree. Its first cost, or repairs, cannot yet be satisfactorily determined, this being the first, and a first machine of any kind always costing more than succeeding ones. Its weight has not been published, but, without doubt, is considerably more than that of the steam-engine, with boilers, water, &c., and the space occupied in the ship may be similarly estimated. The space and weight we suppose to be several hundred per cent. greater than the usual marine steam-apparatus of the same power. In fuel there is experienced an economy, *how* great depends on how much coal is burned and how much power generated under all the usual varying circumstances. Capt. E. objects to our proposed answer to his question on coal and speed, by elaborate calculations, and insists on a direct answer to the following question:—Is there a steamship in existence, of 40 feet beam and 18 feet draught of water, capable of running at a rate of 7 miles per hour on 9 tons of coal per day? We presume there is not; nor is there a clipper ship which can be worked economically by a single sailor. The fuel must be proportioned, in some degree to the engines. Perhaps the nearest approach to the dimensions of the Ericsson is the new steamer John L. Stevens, which is reported as now steaming 10 miles per hour on 12 tons per day.

	Length on deck.	Breadth of beam.	Depth of hold.
Ericsson,	260	40	27
J. L. Stevens,	285½	40	27

The average draught of the Stevens when loaded, we have not at hand, but any extraordinary excess in the Ericsson argues great weight in her machinery. Assuming, according to the usual mode of computation, that the power required to propel a vessel is somewhat proportional to the cross-section, angles of entrance and clearance, and cubes of the velocities, the power required to propel the two should be—

Ericsson, $7^2 = 49$,
J. L. S., $10^2 = 100$,

indicating that 9 tons on the latter *would* give a greater speed than that claimed for the Ericsson,—and making the relative economy of their engines compare as follows:

Ericsson, fuel $4\frac{1}{2}$, performance 49.
J. L. S., " 12, " 100.

But granting a considerable economy of fuel, which there is certainly a fair prospect of obtaining in this engine, both the steam and caloric vessel must, in order to compete successfully with sailing-vessels, be swift and sure. Their sharp hulls, if rigged with suitable spars and sails, would make good passages, the expensive mechanism is added to make them still fleeter. Has this single object been accomplished in the case of the ship in question? The main object, the *whole* object for which the marine engine is employed, is—shall we say—defeated. At the rate with which the Ericsson made the passages from New York to Alexandria and return, the passage to Liverpool would be performed in from 25 to 50 days; at the rate of 7 miles per hour, attained in smooth water under favorable circumstances, the passage might be made in 17 or 18 days. It having been proved impracticable to employ sails to any considerable extent in the presence of paddle-wheels, the caloric ship assumes an intermediate position, possessing the inconvenience of steam and the slowness of the clipper. Sailing-packets have repeatedly made the passage between American ports and Liverpool in 14 days, and the solitary fact that the new power must compete with sailing rather than steaming vessels, is sufficient, until some new facts are developed, to establish the deliberate opinion that the experiment is, so far, a failure. The argument that if these engines can move the vessel at all, still larger ones can propel her with any velocity required, smacks too strongly of the school-boy to require attention.

Of the success of the air-engine for stationary purposes there is more room to hope. Any desirable weight and space may be allowed for many purposes on the land, and this fact has been made available in the design of some steam-engines for such purposes. The pumping-engines at the Cornish mines in England are celebrated throughout the world for their superior economy of fuel, although the arrangement of the engines and boilers and proportion of power to their weight and space would prove a most miserable failure if applied to marine purposes. It cannot be too often repeated that while it is theoretically possible, by the steam-engine, to obtain many fold more power from coal than at present, it is still more so, even to an infinite degree, by the caloric engine. There is a fundamental principle involved in the "regenerator" of Ericsson, Stirling, and others, which, could it be employed without drawbacks or losses, would allow one ounce of coal per day to pump out the Niagara river, and keep it dry. That principle is the transfer of heat from the outgoing to the incoming medium; or, to generalize the expression still further, it is the successive transfers of heat from a highly expansive medium to one which is less so, and back again. Many practical men oppose this doctrine, and contend that the losses, by obstructing the passages, &c., are always necessarily equal to the gain. This is a mistake. There is no fixed relation between these quantities at all; the loss may, by bad workmanship and bad contrivances, be *greater* than the gain, or it may be less, in a proportion which it is the object of the caloric experimenters to determine. The subject has been considered at a meeting of the Institution of Civil Engineers (British), the general impression, as we gather from the report, being against the possibility of thus increasing power. Now we wish to suggest a theoretical case, as follows: Suppose a certain quantity of air, of iron, and of heat, to be inclosed together in a vessel from which neither could escape. Now if the quantum of heat could be first concentrated in the metal, then diffused in the air, then again in the metal, and so continually changed, would not the pressure on the inside of the vessel change with each transfer of heat; and would not a piston, fitting properly in an open end and properly balanced, be alternately driven out and in with a certain degree of force, and that without any escape of heat? This question can only be answered in the affirmative. The heat when in the small volume of metal would expand it but a trifle; transferred to the larger volume of air, it would develop a power proportional to the difference in expansion between the metal and the gas with equal increments of heat. This is the simplest case that occurs to us by which to illustrate the fundamental principle of the regenerating engines. The particular arrangements, using the same or different air, the wires, tubes, and other details, are all merely modes of application. There is the principle, one which has yet to be proved to be of any considerable value, but which theoretically is able to multiply the present effect of heat to an indefinite extent.

The words "any considerable value" are used in this connection, because the principle of transferring heat from the outgoing to the incoming medium is actually employed in the steam-engine every day and in every direction. Each unit of heat that is transferred from the exhaust steam to the feed water is so far a step in the direction which Ericsson and others are now diligently exploring. Air or other gases are used only because they are supposed to offer better facilities for extending this principle.

The question with which we commenced this article cannot be answered properly without a knowledge of all the results of the experiment. These have not been published, and the reluctance with which the facts are doled out is perhaps one of the most remarkable features of the whole affair. The paucity of facts with regard to the trip to Washington is notorious. The earlier trial trips in the harbor, so far from being careful scientific experiments worthy of the importance of the subject, have appeared like child's play,—a sort of "sell" played off on the reporters,—an effort to manufacture public opinion by wine and models in the cabin, or allowing gentlemen to amuse themselves by riding up and down on the pistons. It is believed that none who, from their position or profession, were supposed to be in any degree familiar with mechanical engineering, were invited to the trial trips. We are positive that no names of those employed on the seventy or eighty steamships, or on the twice that number of steamboats running from this city, or in or about the several large and small machine shops, were appended to the document affirming its complete success, as published in the papers of January 12th; and it is equally true that no editor or reporter was invited to either trial trip from the three prominent mechanical journals of this city, although the second trial trip was for the especial benefit of the press. Such a policy is perfectly proper in the early stages of an invention, but is not the way to convince the world of its complete success when it is finally and fairly brought out.

In conclusion, let us again briefly define our position. *We recognize the possibility of a great economy over that of the steam-engine, but deny that its practicability has yet been demonstrated.* We look with considerable interest to the performance of the various air-engines now in construction, among which those of the Evening Post, mentioned above, are considered quite promising, and will keep those who choose to read, posted up on the subject, to the best of our ability. While endeavoring to do justice to the *subject*, we profess to hold no prejudice with regard to the claims of individuals, and hereby agree to give full credit to the first proof of superior economy which shall be presented by the working of any air or other engine, measured either by the friction brake or by the performance of any measurable work.

Apprentices' Department.

Answers and Explanations of Questions on page 93.

9th. The weight of water required to completely fill the boiler is 18,959 lbs.

The area of the circular end (found by Problem 3) multiplied by the length gives the whole contents of the cylinder; the dimensions being all taken in feet the contents will be cubic feet. The contents of the flues must then be found in the same manner, and subtracted from the former. Having thus obtained the volume of water in cubic feet, multiply by 62½ or 62·5 and the weight is obtained in avoirdupois lbs.

10th. The weight of the whole casting is 18,918½ lbs.

The solid contents of the casting, taking the dimensions in feet, are 28 × 6 × ·25 = 42 solid feet. The weight of this mass is to the weight of water as their specific gravities: therefore by simple proportion,

1 : 7·207 :: 62·5 : 450·44

450·44 lbs.* then is the weight of cast-iron per cubic foot, and 42 × 450·44 = 18918·4 lbs. = the weight of the whole casting.

11th. No answers having been received to Question 11th, we are induced to repeat it, simply explaining that one element of no importance is purposely introduced to confuse the student.

Questions.

Question 11.—A certain bowling alley is four feet wide, and the surface, though perfectly plane, is inclined transversely to its length to the extent of ⅛ inch to the foot; in other words, the surface is a half inch lower on one side than on the other. Now, if a ball weighing 10 lbs., and of a diameter equal 8 inches, is rolled with a velocity of 30 feet per second, and aimed directly at the centre of a pin 6 inches in diameter, will it hit the pin, and if not, by how many inches will it clear it, supposing the distance to be 60 feet?

Question 12.- What is the contents of a stick of timber 8 feet square at one end, and tapering regularly to a point at the other end, the length of the stick being 100 feet?

Question 13.—Assuming the weight of a cubic foot of sea-water to be 1026 avoirdupois ounces, and assuming the sea to be of equal density at all depths, what is the pressure per square inch on the bottom at the depth of 8¾ miles (which were the soundings obtained by Capt. Denham, as detailed on page 87)?

Question 14.—A beam, the weight of which is 12 lbs., and its length 18 feet, is supported at both ends; a weight of 56 lbs. is suspended at 3 feet from one end, and a weight of 24 lbs. at 8 feet from the other end. Required the pressure on each support.

Question 15.—A block of wood, supposed to be perfectly non-elastic, and weighing 100 lbs., is resting on ice, supposed to be perfectly frictionless. This block is struck fair by a cannon-ball, weighing 10 lbs., non-elastic, and moving at a velocity of 100 feet per second, the effect will evidently be that the ball will drive the block along on the surface of the ice; but if a non-elastic fender is attached to the block in such a manner that the ball will break, split, or crush it before reaching the solid block, will the mass be driven along with the same velocity as before, supposing the weight of the fender to be of no importance?

Correspondence.

[For Appletons' Mechanics' Magazine.]

The Rifle and its Projectiles.†

To one not considering the subject attentively, it would seem that the axis of revolution of a body projected from a rifle must coincide with the line of flight; that such is not the case will appear from the fact that a missile (and this fact is particularly noticeable at long ranges) goes up, instead of down, in passing *through* the target; that is, the hole where the ball enters is nearer the ground than the end of the hole where it passes out of the target. The reason of this will be evident on inspecting Fig. 8, which is intended to represent the curve described by the projectile in passing from the gun to the target. A B represents the axis of the gun; in its first position, at *c*, the axis of the slug will, or *should*, coincide with it; in the second position, *e d*, the axis of the slug diverges considerably from the line of flight, but is still parallel to the line A B. At *f g* the divergence is still more apparent, and when the projectile reaches the position *n* it will pass through the target in the direction of its axis of revolution.

When the axis of the slug does not coincide with the axis of rotation the

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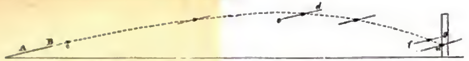
* The West Point Foundry Association of Cold Spring, N. Y., ascertained the weight of cast-iron to be 450·55 lbs. per cubic foot. Other experiments have given a weight of 451·52 lbs., as given in a note to Haswell's Pocket-Book.

† Continued from page 94.

Fig. 3.



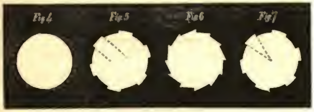
projectile is in a position of unstable equilibrium, and will not, in all probability, strike with its point forward, but with its side or its blunt end; this is the source of the evil produced by "starting" the slugs with the point on one side of the centre of the bore.

Great enthusiasm has been lately excited by the accounts which have reached us of the "terrible effects" of the new Prussian breech-loading rifle, and many inventions have been patented, in this country, within the last two or three years, for the purpose of performing with greater ease and certainty what it is said that will do. It is reported that this rifle will, at two hundred rods, hit a target six feet high by twenty-two inches wide, three times in five shots. I must confess I am rather incredulous about its hitting a target twenty-two inches wide so often, but if it is true I have no doubt that there are marksmen in America who can do as well. If there is any man who can do this I hope he will speak—recollect it is *not* to be done with telescopic sights.

Jennings' breech-loading rifle, which uses a slug, elongated behind into a hollow cylinder, which contains the charge of powder, is an attempt to obtain greater celerity in loading. These guns were at first rifled with the plain twist, and performed but poorly; latterly, however, they have been rifled with the gaining twist, and shoot very fairly.

Of Porter's rifle I have seen but slight accounts. It appears to be an improvement on the foregoing.

The last improvement in this weapon is the rifle patented by Marston. One of the peculiarities of this gun is, that it uses common caps, and so does not compel its possessor to send a hundred or two miles to procure caps or priming of any sort.



A word in conclusion, on the subject of rifling. There are four or five different methods of rifling now more or less in vogue. In this country, those shown in Figs. 5, 6, 7 are entirely used.

The form shown in Fig. 7 is objectionable, because the sharpened edge of the land is apt to cut the patch, and this tendency increases as the lands are made more dovetailing.

Fig. 4 is intended to illustrate a new mode of rifling introduced in England. The barrel is bored as usual, and then worked with a cutter to an elliptical form (twisted, of course). Of this form it may merely be said, that it has all the disadvantages of the belted ball, and that it renders the gun totally unfit for shooting where the object is to hit the mark.

Chapman says, in the work I have before referred to, that "the gaining twist is not a straight line, but an arc of a circle." Will not some enterprising gunsmith try a portion of a parabola for the same purpose?

A. O. B.

[For Appletons' Mechanics' Magazine.]

The Rifle Ball.

On page 94, under the head of "The Rifle and its Projectiles," it is stated that the vacuum formed by a flat slug must be equal to the resistance of one pound "holding the slug back," during its flight. Now if this be true (and it appears reasonable, if the calculations on velocity be correct), why not make the slug of the form represented by the dotted line, or fill the vacuum with lead, and gain the additional weight of metal with the same resisting surface, as we have now two means of steadying the ball, one, its centrifugal force, the other, the groove lately introduced?

We have always denied the position that a more direct force is applied to the flat-ended slug than to the round or long one, as the pressure exercised on the sides of the ball projecting into the powder must be equal, and the ball must in any case receive the full force of the powder.

We have also always believed that the true shape of slug for the improved rifle is that of a steamboat, if we could but find means to steady it, as the same principles of resistance govern both.

R. G. H.

Will A. O. B. favor us with his opinion of the telescopic sight, as we are about to have one?

New Publications.

"The Complete Practical Distiller, including all the most recent Improvements, &c." By M. La Fayette Byrne, M. D. H. C. Baird, Philadelphia.

This is another of the extensive series of practical books now being issued by this enterprising publisher, and purports to be an exact theoretical and practical description of the art of distillation and rectification, simplified and adapted to the use of farmers and others as well as extensive distillers. It is illustrated by numerous cuts.

"The Mississippi and Ohio Rivers." By Charles Ellet, Jr., C. E. Lippincott, Grambo & Co., Philadelphia, 1853.

Mr. Ellet places before us, in this handsomely illustrated volume, the results of his investigations and surveys on these rivers, ordered by a recent act of Congress. They were originally embodied in a Report to the War Department, and published in the Documents of the Senate. Though somewhat open to criticism on account of repetitions, its style is in the highest degree clear and interesting, and it will be found a most important practical treatise on the laws and phenomena of great rivers generally. Taking nothing for granted with regard to the flow of rivers, or rather endeavoring to prove, by actual experiment, the generally received formulas, our author has shown that the results obtained by the European authorities are not sustained when applied to deep and rapid rivers. In some respects his results differ from all the popular theories. He finds the velocity of the stream diminished not only at the sides and bottom, but also at the top! A float, to which a weight was attached at the extremity of a line 50 feet long, might be supposed to drift down the stream with a velocity less than a free and unloaded float, which latter would partake only of the surface velocity, yet, in Mr. Ellet's experiment, the loaded float moved the fastest, indicating an average velocity two per cent. less at the surface than the mean velocity throughout the whole section of the river at any point. This diminution is ascribed to the friction of the air, and, although somewhat smaller, the surface velocity is assumed throughout the calculations as the mean velocity of the river. The work contains a large amount of facts bearing on the past, present, and probable future condition of the Mississippi valley, and will be intensely interesting to the general reader in that great and growing section of our country. It investigates the causes of the freshets, the reasons for their gradual and certain increase in height as the country becomes settled and drained, and points out what is, in his opinion, the best and only method of effectually protecting the valuable lands on the lower Mississippi from threatened destruction, and of maintaining, to some extent, an equal flow of water in the channels of great rivers throughout the year. Engineers may differ with regard to the expediency of adopting his suggestions, but it is believed that they have generally acceded, in a great measure, to their soundness. We intend, in a future number, to notice this subject more at length.

"The Practical Brass and Iron Founder's Guide, a concise Treatise on the Art of Brass Founding, Moulding, &c., by James Larkin." A. Hart, late Carey & Hart, Philadelphia.

Of this 12mo. volume, of about 200 pages, we cannot well speak too highly. The author remarks, in his preface, that he has been practically employed in the business for thirty-four years, having conducted all its branches in one of the largest *ateliers* in Paris, in the British government works, Woolwich, and in the Penn Works, Philadelphia. A large proportion of the work is made up from papers contributed by the author to different mechanical and scientific publications, which have been revised for the purpose; but though, to a great extent, the production of a single mind, there appears no effort throughout the body of the work to claim originality for the various receipts and valuable information furnished. On the contrary, this little volume possesses in a high degree a merit quite rare among late mechanical books, that of distinctly stating its authority in each instance.

The following comprehensive table, which we do not recollect to have seen in any previous work of the kind, includes a large number of the principal brasses and bronzes.

TABLE OF EXPERIMENTAL RESULTS AS TO SOME OF THE CHEMICAL AND PHYSICAL PROPERTIES OF THE ATOMIC ALLOYS OF COPPER AND ZINC, AND OF COPPER AND TIN; BY R. MALLET, M. R. I. A., ASS. INS. C. E., ETC.

TABLE I.—Showing the Chemical and Physical Properties of the Atomic Alloys of Copper and Zinc.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
No. of Experiment.	Chemical Constitution.	Composition by weight per cent.	Atomic Weight, Hydrogen being taken as 1.	Specific Gravity.	Color.	Fracture.	Ultimate Cohesion, per square inch in tons.	Order of Ductility.	Order of Malleability at 60° Fahrenheit.	Order of Hardness, &c.	Order of Fusibility.	Characteristic Properties, in Working, &c.	Relation to Cast-Iron, in presence of a solvent, i. e. Sea-Water.
1	C. +	100·00 + 0	31·6	8·667	Tile Red.	E.	24·6	8	1	22	15	Well known.	
2	10 C. + Z.	90·70 + 9·30	348·3	8·605	Reddish yellow, 1	C.C.	12·1	6	13	21	14	Similor, &c. Several of these are malleable at high temperatures	All these alloys increase the corrosion of Cast-Iron in Sea-Water, when in their presence.
3	9 C. + Z.	89·80 + 10·20	316·7	8·607	Reddish yellow, 2	F.C.	11·5	4	11	20	13		
4	8 C. + Z.	88·70 + 11·30	285·1	8·633	Reddish yellow, 3	F.C.	12·8	2	10	19	12		
5	7 C. + Z.	87·70 + 12·30	253·4	8·587	Reddish yellow, 4	F.C.	13·2	9	8	18	11		
6	6 C. + Z.	85·08 + 14·92	221·9	8·591	Yellowish red, 3	F.F.	14·1	5	9	17	10		
7	5 C. + Z.	83·02 + 16·98	190·3	8·415	Yellowish red, 2	F.C.	13·7	11	2	16	9	Bath Metal.	
8	4 C. + Z.	79·65 + 20·35	158·7	8·448	Yellowish red, 1	F.C.	14·7	7	3	15	8	Dutch Brass.	
9	3 C. + Z.	74·58 + 25·42	127·1	8·397	Pale yellow.	F.C.	13·1	10	4	14	7	Rolled Sheet Brass.	
10	2 C. + Z.	66·18 + 33·82	95·5	8·299	Full yellow, 1	F.C.	12·5	3	6	13	6	British Brass.	
11	C. + Z.	49·47 + 50·53	63·9	8·230	Full yellow, 2	C.C.	9·2	12	5	12	6	German Brass.	
12	C. + 2 Z.	32·85 + 67·15	96·2	8·283	Deep yellow.	C.C.	19·3	1	7	10	4	Brass, Watchmakers,	
13	8 C. + 17 Z.	31·52 + 68·48	801·9	7·721	Silver white, 1	C.	2·1	0	22	5	5	Very Brittle, Too hard to file or turn, lustre nearly equal to Speculum Metal.	All these alloys decrease the corrosion of Cast-Iron in Sea-Water, when in their presence.
14	8 C. + 18 Z.	30·30 + 69·70	834·2	7·836	Silver white, 2	V.C.	2·2	0	23	6	5	Very Brittle,	
15	8 C. + 19 Z.	29·17 + 70·83	866·5	8·019	Silver gray, 3	C.	0·7	0	21	7	5	Very Brittle,	
16	8 C. + 20 Z.	28·12 + 71·88	898·8	7·603	Ash gray, 3	V.	3·2	0	19	8	5	Brittle,	
17	8 C. + 21 Z.	27·04 + 72·96	931·1	8·058	Silver gray, 2	C.	0·9	0	18	9	5	Brittle,	
18	8 C. + 22 Z.	26·24 + 73·76	963·4	7·882	Silver gray, 1	C.	0·8	0	20	3	5	Very Brittle,	
19	8 C. + 23 Z.	25·39 + 74·61	995·7	7·443	Ash gray, 4	F.C.	5·9	0	15	1	5	Barely Malleable.	
20	C. + 3 Z.	24·50 + 75·50	128·5	7·449	Ash gray, 1	F.C.	3·1	0	16	2	4	Brittle.	
21	C. + 4 Z.	19·65 + 80·35	160·8	7·371	Ash gray, 2	F.C.	1·9	0	14	4	3	White Button Metal.	
22	C. + 5 Z.	16·31 + 83·69	193·1	6·605	Very dark gray.	F.C.	1·9	0	17	11	2	Brittle.	
23	+ Z.	0 + 100·00	32·3	6·895	Bluish gray.	T.C.	15·2	13	12	23	1	Brittle, well known.	

TABLE II.—Showing the Chemical and Physical Properties of the Atomic Alloys of Copper and Tin.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
No. of Experiment.	Chemical Constitution.	Composition by weight per cent.	Atomic Weight, Hydrogen being taken as 1.	Specific Gravity.	Color.	Fracture.	Ultimate Cohesion, per square inch in tons.	Order of Ductility.	Order of Malleability at 60° Fahrenheit.	Order of Hardness, &c.	Order of Fusibility.	Characteristic Properties, in Working, &c.	Relation to Cast-Iron, in presence of a solvent, i. e. Sea-Water.
1	C. +	100·00 + 0	31·6	8·667	Tile Red.	E.	24·6	1	2	10	16	Well known.	Every Alloy of C. + T. increases the corrosive action of Sea-Water on Cast-Iron, in their presence; the maximum increase is due to Tin.
2	10 C. + T.	84·29 + 15·71	374·9	8·561	Reddish yellow, 1	F.C.	16·1	2	6	8	15	Gun Metal, &c.	
3	9 C. + T.	82·81 + 17·19	343·3	8·462	Reddish yellow, 2	F.C.	15·2	3	7	5	14	Gun Metal, &c.	
4	8 C. + T.	81·10 + 18·90	311·7	8·459	Yellowish red, 2	F.C.	17·7	4	10	4	13	Gun Metal and Bronze.	
5	7 C. + T.	78·97 + 21·03	280·1	8·728	Yellowish red, 1	V.C.	13·6	5	11	3	12	Hard Mill Brasses, &c.	
6	6 C. + T.	76·27 + 23·73	248·5	8·750	Bluish red, 1	V.	9·7	0	12	2	11	Brittle, All these alloys found occasionally in bells, with mixtures of Zinc and Lead.	
7	5 C. + T.	72·80 + 27·20	216·9	8·575	Bluish red, 2	C.	4·9	0	13	1	10	Brittle,	
8	4 C. + T.	68·21 + 31·79	185·3	8·400	Ash gray.	C.	0·7	0	14	6	9	Crumbles,	
9	3 C. + T.	61·69 + 38·31	153·7	8·539	Dark gray.	T.C.	0·5	0	16	7	8	Crumbles,	
10	2 C. + T.	51·75 + 48·25	122·1	8·416	Grayish white, 1	V.C.	1·7	0	15	9	7	Brittle,	
11	C. + T.	34·92 + 65·08	90·5	8·056	Whiter still, 2	T.C.	1·4	0	9	11	6	Small Bells, Brittle.	
12	C. + 2 T.	21·15 + 78·85	149·4	7·387	Whiter still, 3	C.C.	6·9	0	8	12	5	" Brittle.	
13	C. + 3 T.	15·17 + 84·83	208·3	7·447	Whiter still, 4	C.C.	3·1	0	5	13	4	Speculum Metal of authors.	
14	C. + 4 T.	11·82 + 88·18	267·2	7·472	Whiter still, 5	C.C.	3·1	8	4	14	3	" Files Tough.	
15	C. + 5 T.	9·68 + 90·32	326·1	7·442	Whiter still, 6	E.	2·5	6	3	15	2	" Files Soft & Tough.	
16	+ T.	0 + 100·00	58·9	7·291	White, 7	F.	2·7	7	1	16	1	Well known.	

Abbreviations used in column 7th to denote the character of Fracture:—F.C. Fine Crystalline, C.C. Coarse Crystalline, T.C. Tabular Crystalline, F.F. Fine Fibrous, C. Conchoidal, V C. Vitreo-Conchoidal, V. Vitreous, E. Earthy.

The maxima of ductility, malleability, hardness, and fusibility, are = 1.

The numbers in column 6th denote intensity of shade of the same color.

The atomic weights are those of the hydrogen scale.

The specific gravities were determined by the method indicated in report "On Action of Air and Water on Iron," Trans. Brit. Ass. vol. vii. p. 283.

The ultimate cohesion was determined on prisms of 0·25 of an inch square, without having been hammered or compressed after being cast. The weights given are those which each prism just sustained for a few seconds before disruption.

The copper used in these alloys was granulated, and of the finest "tough pitch;" the zinc was Mosseleman's, from Belgium; and the tin "grain tin," from Cornwall. They were alloyed in a peculiar apparatus, to avoid loss by oxidation, and the resulting alloy verified by analysis.

No simple binary alloy of copper and zinc, or of copper and tin, works as pleasantly in turning, planing, or filing, as if combined with a very small proportion of a third fusible metal—generally lead is added to C. + Z., and zinc to C. + T., as is known to workers in metals.

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"The Dyer's Instructor, comprising Practical Instructions in the Art of Dyeing Silk, Cotton, Wool, and Worsted and Woollen Goods." By David Smith, Pattern Dyer. H. C. Baird, Philadelphia.

Those who have been so fortunate as to possess a copy of the "Dyer's Guide, with Patterns," are sufficiently able to appreciate the highly practical and reliable character of this work, which is by the same author, and includes a far wider range of subjects. The work before us contains nearly 800 receipts, together with a brief treatise on the art of padding, instructions for printing colors, descriptions of dye-wares, explanations of terms, &c. The following convenient and simple tests for the examination of water may be found of service to many of our readers in other branches of business:—

To ascertain if Water be Hard or Soft.—Procure a small quantity of soap dissolved in alcohol, and let a few drops of it fall into a glass of the water to be tried. If the water becomes milky, it is hard; but if little or no milkiness takes place, the water may be said to be soft.

To ascertain if Water contain an Acid.—Take a piece of paper, containing no sizing, and which has been previously stained with litmus, syrup of violets, or scrapings of radishes, and immerse it in the water to be examined; if the paper becomes red, it contains an acid. If a little lime-water be added to the same water, and a precipitate takes place, it is carbonic acid. If dark blue paper, such as is wrapped round loaves of sugar, be converted to red, it contains a mineral acid.

To ascertain if Water contain an Alkali or an Earth.—Take a piece of paper which has been stained with an infusion of litmus, and reddened by vinegar, and immerse it in the water; if the blue color of the paper be restored, it either contains an alkali or an earth.

If a little of the syrup of violets be added to the water which contains an alkali or an earth, the water will become green.

To ascertain if Water contain Iron.—Take a glass of water and add to it a few drops of the infusion of nutgalls, or suspend a nutgall in it, by means of a thread, for twenty-four hours; if iron be present, the water will become of a dark brown or black color.

Prussiate of potash is a still more delicate test for detecting iron. If a crystal, or a drop of it when dissolved, be added to a glass of water containing iron, it will immediately become of a blue color.

To ascertain if Water contain any Substance combined with Muriatic Acid.—Take a glass of water and let a few drops of nitrate of silver fall into it; if a milkiness be produced, which disappears on the addition of a little liquid ammonia, it may be concluded that some salt with muriatic acid is present. Muriate of lime, muriate of soda (common salt), and muriate of magnesia are the salts most generally to be met with in spring-water.

To ascertain if Water contain Magnesia.—Take a quantity of the water, and boil down to a twentieth part of its bulk, then drop a few grains of carbonate of ammonia into a small glass of water. No magnesia will yet be precipitated; but on adding a small quantity of phosphate of soda, if any magnesia be present, it will then make its appearance, and fall to the bottom of the glass. *Observation.*—In this experiment, it is necessary that the carbonate of ammonia be in a neutral state.

To ascertain if Water contain Pure Lime.—Into a glass of the water drop a crystal or two of oxalic acid; if a precipitate takes place, and if another glass of the same water become milky upon blowing air from the lungs into it through a quill, the presence of pure lime, or barytes, may be inferred; but barytes has never yet been found pure in water.

To ascertain if Water contain Carbonic Acid.—Take a quantity of the water, and add to it an equal quantity of perfectly transparent limewater. If carbonic acid be present, either free or combined, a precipitate immediately appears, which on adding a few drops of muriatic acid will again be dissolved with effervescence.

To ascertain if Water contain any Combination of Sulphur.—Put a little quicksilver into a vial of water, cork it, and let it stand for a few hours. If the surface of the quicksilver has acquired a black appearance, and a blackish powder separates from it on shaking the vial, the presence of sulphur may be inferred.

To ascertain if Water contain Lead.—To a little of the water in a glass add an equal portion of water impregnated with sulphuretted gas. If lead be present, it will be known by the color of the water, which will assume a dark brown or blackish tinge. *Observation.*—Lead may be also detected by adding a little sulphuret of ammonia or potash. A similar effect will take place as in the last experiment, if lead be present.

To ascertain if Water contain Copper.—Immerse a polished plate of iron in the water to be examined, and let it remain in a few minutes. If copper be present, the plate of iron will be coated over with copper. *Observation.*—A few drops of liquid ammonia will turn any water containing copper to a deep blue color.

"Perfumery, its Manufacture and Use, with Instructions in every Branch of the Art." By Campbell Morfit, Practical and Analytical Chemist. H. C. Baird, Philadelphia, 1853.

This work is a second edition, revised and improved. It contains recipes for all the fashionable preparations, and is designed especially for the perfumer, druggist, and soap manufacturer. Not confining itself exclusively to perfumes it devotes chapters to the composition and uses of cosmetics, rouges, dentifrices, &c., and must be interesting, if not practically useful, to the ladies, exquisites, and "the public generally."

Monthly Notes.

The idea of an atmospheric telegraph, transmitting parcels through a tube, by exhausting one end and forcing in air at the other, has been again revived, and is attracting considerable attention in the newspapers. The plan is to blow the mail along through a smooth tube, extending the whole distance between two cities. This has been often proposed, but it is now revived by Mr. J. O. Richardson, who is stated to be forming a company in Boston for the construction of such a telegraph between that city and New York, with intermediate stations at the principal places. The precise arrangement of the details have not been published; in these must consist the whole merit of any new invention of the kind.

The model aeroport, or flying balloon, of Mr. Porter and others, has been again exhibited at Washington, and made to propel itself about the room. We do not learn that any material advance has been made since the same was done in the Tremont Temple at Boston about the year 1850. We learn nothing new of the progress of the large one, designed to carry passengers.

The steam fire-engine, lately introduced in Cincinnati, is reported to be very successful. It weighs about four tons, looks like a locomotive, is drawn by four horses, and managed by four men. Steam is raised to a working pressure in ten or twelve minutes, generally by the time the fire is reached, and it is said to do the work of 12 ordinary engines, manned by 800 men. The only serious difficulty attending its use seems to be the difficulty of moving it about the streets, its weight seriously threatening the destruction of the pavement.

An experiment is in progress for testing the value of zinc as a material for vessels. A zinc sloop, the first manufactured of that metal in Europe, has been lately launched. Iron is used, to a slight extent, in the framework, and the deck and upper-works are of wood.

The appointment of Judge Mason, of Iowa, as Commissioner of Patents, appears to have given very general satisfaction. Mr. Thomas H. Faron, of this city, has been named in connection with the station of Engineer-in-Chief of the Navy. A more capable and efficient man could hardly be named, or one whose appointment would be more generally acceptable to all parties concerned.

The work on the Crystal Palace is progressing rapidly, with the expectation of opening by the first of June. Many applications for space have been rejected for want of room. Extra space has been provided for running machinery since the publication of our drawings on page 35, by filling up the triangular spaces between what we styled the "Arcade" and the main building, and making these, and also the Arcade, two stories high. The upper stories are to be principally devoted to agricultural and other machines not in motion. We learn that several railroads, including the lines between Schenectady, Utica, Syracuse, and Rochester, have agreed to transport goods, both to and from the exhibition, free of charge; the goods to be at the owners' risk, and accompanied by a certificate of their having been admitted to exhibition. Mr. Joseph E. Holmes is general superintendent of machinery, Prof. B. Silliman, Jr., of minerals, and Col. B. B. Johnson, of Albany, of agricultural articles. The glass is supplied by Messrs. Cooper & Belcher, of Camptown, N. J., and is enamelled by a new process, producing the effect of ground glass. The managers offer a prize of $200 for the best design for a prize-medal to award to exhibitors. We intend devoting a large share of attention to the subjects of this exhibition, should they appear worthy of it, and take this occasion again to invite exhibitors, and all other persons possessing valuable inventions or facts, not sufficiently known, to communicate with us.

Coal-burning locomotives are reported to have been much improved of late. Several companies in Pennsylvania are using the Mulholland locomotives, burning anthracite, without any extraordinary destruction of the fire-boxes. Norris is now building five of this description for the Camden Railroad.

To Readers and Correspondents.

E. R. S. Your favors will be always acceptable.

"ENGINEER, N. Y." "Had Hall's Surface-condenser two tubes, one within the other, the annular space between being the condenser, and cooled by water outside the outer tube and inside the inner one, or had it a single tube only?" So far as we are now aware no form of Hall's Condenser had any such double tube. Mr. J. M. Miller patented, in 1851, an arrangement for sugar vacuum-pans, by which a tube returned into itself some distance, allowing the cold water thus to enter the interior, but not to circulate through. We believe this has been tried as a condenser for steam-engines, but with what success we cannot say.

R. T. V., Conn. Wiesbach gives the following as the condensed result of a series of calculations:—"The centrifugal force is to the weight of the body as twice the height due to the velocity is to the radius of revolution." The following more convenient and simple rule gives somewhat near the same result, and is recommended as a general rule for finding the amount of centrifugal force:—"Divide the velocity in feet per second by 4·01, square the quotient, and divide by the diameter of the circle in feet, then multiply this last quotient by the weight of the body in lbs., the result is the centrifugal force in lbs."

B. W., Ill. The trembling effect produced on surrounding objects by the falling of water over a dam has been often very troublesome. We have known one case where it was completely removed by placing planks in such manner as to receive the sheet of water on an inclined plane, at the foot of the dam. We should judge the inclination of the plane to have been about 30° from the horizontal.

J. O. McL., La. Always, when the conditions are similar.

T. A., Penn. There has been any quantity of experiments tried essentially as you suggest. On a large scale they are always failures. One was tried in this city last season on a large boat. Water was drawn through the bottom and ejected from the stern under water. The engine did its best, without tightening the hawsers by which the boat was attached to the wharf.

"AN INTERESTED INQUIRER," Mich. Without having devoted much attention thereto, our impression is certainly in favor of the correctness of Maj. Barnard's calculations on pages 82–88. The calculations on page 89 we are certainly ready to endorse. Capt. Ericsson has asked space to reply to Maj. Barnard in our next number, from which we anticipate many valuable facts, but no material correction of the theory so skilfully developed by the latter.

A number of communications are laid over. Most of the remaining inquiries are answered in the editorial article on the Caloric Engine and the notice of the Crystal Palace in the Monthly Notes. There will be no charge to exhibitors for admission to the exhibition, for themselves or assistants to explain and attend the articles. Goods may be received on exhibition for a shorter time than one season at the discretion of the managers, but the chances of securing a place at a late day for any articles requiring considerable space will probably be very small indeed. This is the best information we can furnish upon the subject.

APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 6.—Vol. III.—JUNE 1st, 1853.

[For Appletons' Mechanics' Magazine.]

OBSERVATIONS ON MAJOR BARNARD'S CALCULATIONS RELATIVE TO THE THEORETICAL POWER OF THE CALORIC ENGINE.

BY J. ERICSSON.

The object of Major Barnard's calculations appears to be to prove that, theoretically considered, the power of the caloric engine is insufficient for practical purposes.

In testing the value of the Major's views on the subject, I will adopt a different mode of demonstration from that employed by him,—one that will be comprehended by *all*. It will rest simply on the well-known fact, that under uniform temperatures the pressure of atmospheric air increases and diminishes in the inverse ratio of the space it is made to occupy. By reducing that space, for instance, one half the pressure becomes doubled, and by doubling the space the pressure becomes reduced one half; provided time be allowed for establishing equal temperatures. The proposed demonstration will further rest on the fact, that increase of density is attended with diminished capacity for heat, and reduced density with increased capacity for heat; in other words, compression elevates the temperature, whilst expansion is attended with a corresponding fall of temperature.

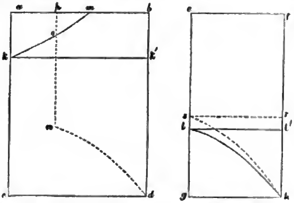
It is proper to observe that Major Barnard has omitted several important elements in his analysis which renders the entire calculation erroneous, and the conclusions worthless. The increase of the volume of air furnished by the supply cylinders occasioned by elevation of temperature during compression, is omitted. It will be shown presently that this increase of volume amounts to 173·3 cubic feet for each stroke of the engines of the caloric ship, exerting a force of 299,462 pounds raised one foot high during each stroke.

The rate of speed, 120 feet per minute, assigned to the pistons as the maximum is wholly gratuitous. There is not the slightest ground for limiting their speed to that slow rate. Quick motion is a leading feature in the caloric engine, and in no instance has it yet been found that the heating of the air has not been performed with sufficient rapidity. In the large test engine with 72-inch cylinders, upwards of 40 turns per minute have been made; and with 30-inch pistons upwards of 100 turns per minute have not furnished any evidence that the heating was too slow. Major Barnard, in questioning the capacity of the furnaces in this respect, appears to overlook the fact that the regenerators are the principal heaters. The amount of caloric transferred by this instrument evidently depends on the rapidity of the changes which pass through it; consequently, if it contains a sufficient amount of heating surface, the duty of the furnace will mainly be that of supplying heat lost by radiation, &c., which is no more at high than low speed.

The effect of the momentum of the heavy pistons in counteracting irregularity of motion, is also entirely overlooked. This latter oversight, and the assumed necessity of carrying the active force to the termination of the stroke, has induced Major Barnard gravely to consider the propriety of employing working and supply cylinders of equal magnitude. The reflecting engineer will be more amused than instructed by that branch of the investigation, as he will perceive at a glance what an enormous waste of power would attend the adoption of such proportions. It will appear presently that with a working pressure of 12 pounds to the square inch, and with 4 pistons of 14 feet diameter moving at the rate of 200 feet per minute, upwards of 1000 horse-power would be thrown away by adopting the proposed absurd proportions of cylinders. I do not propose, however, to follow Major Barnard through his analysis of absurdities; I will proceed at once to consider the machine as it has been carried into practice in the caloric ship, and endeavor to prove its theory such as to render its practical utility less problematical than Major Barnard imagines.

On numerous practical considerations, which I shall omit to discuss at present, the working and supply cylinders have been made to bear a proportion of 3 to 2, and the admission of air from the receivers is cut off at ¾ of the up-stroke. The diameter of the working cylinder is 168½ inches, the area 22,300 square inches. The diameter of the supply cylinder 137½ inches, and the area 14,866 inches. Each cylinder has 6 feet stroke.

In order to free the subject from symbolical mystification, the horror of all practical men—a mystification which smatterers invariably inflict on them—I will present the whole question in a diagram resting on a simple geometrical basis.



The rectangle *a b d c* represents the magnitude of the working cylinder, and *e f g h* that of the supply cylinder; *a b* being to *e f* as 3 to 2, *a c* and *e g* each 6 feet. *c d* and *g h* represent the working and supply pistons. *k* marks the point of cut-off in the working cylinder, and *l* the position of the supply piston when the pressure shall have attained 12 pounds + pressure within the cylinder. *m b* represents the final pressure in the working cylinder when the piston shall have reached the full up-stroke, whilst *k k'* represents the maximum pressure of 12 pounds. *k o m* is a curve, the ordinates of which, erected on *b k'*, represent the pressure under the working piston during its motion from *k'* to *b*. *h l* is a similar curve, the ordinates of which erected on *l' h*, represent the pressure on the top of the supply piston during its motion from *h* to *l'*, *l l'* representing the maximum pressure of 12 pounds. *s r* marks the position of the supply piston where the maximum pressure of 12 pounds would take place if no increase of volume attended the increase of temperature during compression; *s h* is the curve indicating the ratio of increase of pressure as before stated. It will be evident that under the conditions stated, the figure *k m b d c* represents exactly the power exerted by the working piston, whilst *e f h l* exhibits exactly the amount of resistance of the supply piston. If, therefore, the latter figure be transferred to the former, as indicated by *p b d n*, it will be evident that *k o n d c* exhibits exactly the differential force of the two pistons, and that *p m o* represents the exact amount of *counteracting* force at the termination of the stroke. By giving value to the quantities thus represented, we may at once determine the differential or disposable force of the machine. Before entering on this calculation, it will be proper to consider whether the favorable conditions of force and resistance exhibited by the diagram do not conflict with the narrow limits of temperature within which the expansion must be confined. The admission of air being cut off at ¾ in the working cylinder, it follows that the supply of air after expansion by heat must be equal to ¾ of the volume of said cylinder. In determining the quantity of compressed air furnished by the supply cylinder, the law of Mariotte cannot be adopted, in consequence of the great elevation of temperature which takes place in practice during continued working. The desired force being 12 pounds + pressure, and *e g* being = 6 feet, it follows that the position of *s r* will be 3·33 feet below *e f* if the temperature remains constant, for 15 + 12 = 27 : 15 :: 6·00 : 3·33. But an elevation of temperature of more than 60° takes place chiefly by compression and partially by radiation from the heated body of the cylinder during constant operation. This increase of temperature swells the volume full one-eighth, so that when the piston arrives at *l l'*, 0·42 foot below *s r*, the maximum pressure is reached. The actual volume of air supplied will therefore be 3·75 × *e f* to fill ¾ of the volume of the working cylinder, or 4·50 × *a b*. Hence 3·75 × 2 = 7·50 must be made to fill 4·50 × 3 = 13·50. By an elevation of temperature of 480° the volume of 7·50 would swell to 15·00. Consequently an increase less than 480° will suffice, viz., in the following ratio, 15·00 : 13·50 :: 480° : 432°, the actual increase required.

Having thus proved that with a supply cylinder only ⅔ of the working cylinder and the cut-off prolonged until ¾ of the stroke, an impracticable temperature will not be required, we will now proceed to determine the differential force produced under these favorable conditions.

The pressure in the working cylinder being constant during ¾ of the stroke, and at that point cut off, it follows, that at the termination it will be 5·25 pounds (4 : 3 = 27·00 : 20·25 — 15·00 = 5·25); calculating the average pressure by taking the means in the ordinary manner practised by engineers, it would be 11·15; by accurate mathematical determination it will be 11·08 pounds. This multiplied by the area of the piston, 22,300 sq. inches, exhibits a mean force of 247,084 pounds. It should here be stated, that whilst the law of Mariotte is not directly applicable to the determination of force after expansion in the steam-engine, on account of the fall of temperature; yet in the case of the working cylinder of the caloric engine that law is directly applicable on account of the accession of temperature from the heater, after the closing of the cut-off valve. The mean of the resistance against the supply piston by accurate determination on the data already furnished, is 9·33 pounds to the sq. inch, which multiplied by the area 14,866, exhibits a mean resistance of 138,699 pounds. This deducted from the mean force, gives an excess of 108,385 pounds. Considering that the working pressure is only 12 pounds, such an excess of force is very remarkable. This will become still more apparent if we divide it by the differential area of the two pistons, 7434 inches. By so doing we establish the fact, that an active pressure of 14·57 pounds to the sq. inch is developed on an area measured by 97¼ inch diameter. In view of this very efficient active force on a differential area of such magnitude, Major Barnard and others will find it useless to look for other proportions of cylinders and other degrees of cut-off. Besides, theorizing on the subject in the absence of practical information, is not only profitless but injurious to those who read to be instructed.

It has been already stated that the slow rate of speed assumed by Major Barnard is wholly unsupported by experience. Now had he simply undertaken to show what power had so far been developed in the caloric ship, he would have been justified in assuming ten turns a minute as the maximum—10¼ turns being the highest speed reached—but he undertakes to prove, that the caloric engine is inapplicable to navigation by a calculation founded on a speed of piston only 120 feet per minute. Leaving the fact out of sight, that maximum pressure has not yet been carried in the ship, from defects in the heaters, hence that maximum speed has not been attained in the engines, I would suggest that Major Barnard, before assuming as a basis for his calculations, a speed of piston less than one half of that of ocean steamers, should have reflected that smaller wheels might be employed, and that the new motor is equally applicable to the screw propeller: either of these applications would give any desired speed to the pistons. The speed of the pistons of first-class ocean steamers is fully 280 feet per minute. In determining therefore the power which engines of the size of those in the caloric ship are capable of producing, it would be quite improper to assume the speed of piston at less than 200 feet per minute, whilst a much higher rate of speed might be adopted with perfect propriety. As the engine consists of four working cylinders of single action, their united effective movement will be through a space of 400 feet per minute; this multiplied by the differential force 108,385, exhibits a power of 43,354,000 pounds raised one foot high per minute, and this divided by 33,000, establishes the theoretical power of the engine to be 1313 horses. Practice alone can determine the *precise* amount to be deducted from this power for various losses.

It was stated at the commencement, that Major Barnard had overlooked the effect of the heavy pistons in regulating the action of the machine, and that this and some other erroneous views had led him to propose cylinders of absurd proportions. It will be proper therefore to ascertain precisely whether the counteracting force at the termination of the stroke of the pistons indicated by the figure *p m o* in the diagram, is of such a magnitude as to call for the objectionable expedients suggested. By reference to the diagram it will be seen, that the counteracting force, viz., the excess of resistance of the supply piston over the force of the working piston, commences at *o*, when the piston is 0·71 feet from the termination of the stroke. The mean excess of resistance whilst the piston passes from *o* to *p* will be found to be 32,335 pounds, which divided on the whole stroke of six feet is only 3826 pounds. The mean effective differential power being 108,385, it will be seen that the counteracting force at the end of the stroke is under $\frac{1}{28}$ of the power developed during the entire stroke—a quantity altogether too insignificant to effect the regularity of any engine provided with an appropriate fly-wheel. In the caloric ship, with connecting-rods acting at right angles, the irregularity is too small to call for any mention whatever. It may be demonstrated, moreover, that the momentum of the heavy pistons of the caloric engine is just sufficient to balance the counteracting force under consideration. At a speed of 200 feet per minute or 3·33 feet per second, mean rate, the velocity of the piston at half stroke will be $\frac{3{\cdot}33 \times 22}{14} = 5.23$ feet per second. According to the well-known laws of gravitation, a body falling from a height of 0·428 feet, would acquire the stated speed of 5·23 feet per second. Now the counteracting force at the termination of the stroke being 32,335, acting through 0·71 foot, it follows that $\frac{32{,}335 \times 0{\cdot}71}{0{\cdot}428} = 53{,}641$ pounds, acting through 0·428 foot, would balance the former. Considering that the weight of the piston absorbs as much force during the first half of the stroke of the piston, as it gives back during the remaining half, it will be evident, that if the weight of the piston were $\frac{53{,}641}{2} = 26{,}820$ pounds, it would just balance the counteracting tendency complained of. It so happens that the pistons of the caloric ship for each pair of cylinders weigh the amount stated within a fraction.

In regard to regularity of power, a mere inspection of the diagram will show that the force exerted during the first and last half of the stroke of the working piston is very unequal. On calculation it will be found that the power developed during the first half stroke is 100 when the power during the last is 32. But in this respect the caloric engine presents no singular features, for in a high-pressure steam-engine carrying 85 pounds pressure, and cutting off at one-fourth of the stroke, the power developed during the first half stroke is to that developed during the remainder as 100 to 28, yet a moderate fly-wheel is found to equalize the motion sufficiently for all practical purposes.

In regard to the startling proposition of Major Barnard, to employ cylinders of equal magnitude, its absurdity will be manifest merely by estimating the power that would be wasted in passing off, or more properly speaking, turning adrift, the air from the working cylinder, at a pressure of 12 pounds, after that pressure had been obtained at the expenditure of force and fuel. Let us calculate what power would be thus thrown away in engines of the magnitude of those in the caloric ship, at a rate of speed of 200 feet per minute of the pistons. The pressure at the moment of opening the exhaust-valves being 12 pounds, calculation shows, that if the piston could pass into a second cylinder it would continue to move for a space of 4·80 feet, exerting a mean force equal to 3·90 pounds to the square inch through a space of 6 feet. The power wasted would therefore be 22,300 × 3·90 = 86,970 × 400 = 34,788,000 pounds raised one foot high = 1054 horse-power. Any further argument need not be employed to discourage the proposition of introducing cylinders of equal magnitude for caloric engines.

The increased volume of air furnished by the supply cylinders, in consequence of elevation of temperature during compression, omitted in Major Barnard's calculations, will be found, by reference to the diagram, to be $\frac{42}{844}$ of the stroke for each supply cylinder, or $\frac{168}{844}$ for all four cylinders; the area of cylinder being 103·2 square feet, the omitted quantity will amount to 173·3 cubic feet per stroke.

In closing these observations, I cannot refrain from adverting to the improper haste with which the results of the trials of the caloric ship have been recorded, and calculations made in disparagement of the new engine. I have repeatedly stated that the yielding of the wrought-iron heaters has prevented full pressure being carried, and I have so reported to government. Strange to say, those who have written on the subject appear not to comprehend the importance of this fact, nor its true bearing on the question. They all confound the caloric engine with the steam-engine. In the latter, when reduced pressure is carried the consumption of fuel is reduced in an equal proportion,—not so in the caloric engine. The principal source of heat being the regenerator, neither speed nor pressure exercises any material influence on the quantity of fuel consumed. I must here emphatically record the fact, that the quantity of fuel consumed in turning the wheels at the dock, at 4½ turns per minute, differed very little from the quantity consumed under way, making 9 turns a minute. The reason is obvious: the losses by radiation, and the heat passed off through the chimney, &c., remain constant, whilst the capability of the regenerator changes with the speed, density of air, and temperature. By increasing these the power of the instrument increases in equal proportion; the more heat it receives in a given time the more it gives back. A moment's reflection on the nature of this singular instrument renders this proposition self-evident; and yet men of talent repeatedly compromise their reputation by putting forth statements to the public, exhibiting their utter unacquaintance with this all-important property of the principal part of the caloric engine.

New York, May 23d, 1853.

[From the Journal of the Franklin Institute.]

Report of Experiments on Gunpowder, made at the Washington Arsenal in 1843 and 1844.

BY CAPT. ALFRED MORDECAI, U. S. ARMY.

THE following selection of results and properties of gunpowder, the loss of force by windage, the effects of wadding, &c., &c., was made by Charles H. Haswell, Marine Engineer, for insertion in a new edition of his Engineers' and Mechanics' Pocket-book, and as it was impracticable for him to appropriate any more space for this subject than that required for the essential elements involved in the general varieties of powder, &c., &c., he was constrained to give but a partial selection of the varieties of powder experimented with.

The report of Capt. Mordecai embraces the results of careful systematic observations effected with the aid of a cannon and musket pendulum, and is of a character not only to manifest his suitability for the labor so judiciously confided to him, but to reflect high honors upon the corps of which he is so distinguished a member.

Table of Results and Properties of Gunpowder, determined by the Experiments and Report of Capt. A. Mordecai, U. S. A.

24-POUNDER GUN.—Weight of ball and wad, 24·25 lbs.; weight of powder, 6 lbs.; windage of ball, ·135 inch.
MUSKET PENDULUM.—Weight of ball, 397·5 grains; weight of powder, 120 grains; windage of ball, ·05 inch.

Kind of grain.	Composition.			Manufacture.		Number of grains in ten Troy grains.	Relative quickness of burning.	Water absorbed by exposure to air.	Relative force. Standard = 1000.				Weight of a cubic foot, loose.	Designation of powder in the experiments.
									24-Pounder gun.		Musket Pendulum.			
	Saltpetre.	Charcoal.	Sulphur.	Where from.	Glazing.				Initial velocity in ft.	Force.	Initial velocity in ft.	Force.		
								Per ct.	Per sec.		Per sec.		Oz.	
Cannon, large	76	14	10	Dupont's Mills, Wilmington, Delaware.	Glazed.	77	275	2·27	1710	984	....	677	916	A 1
small					"	540	314	3·35	1650	985	....	720	927	3
Musket					"	1134	214	....	....	....	1454	806	896	4
Rifle					"	6174	142	....	....	....	....	907	....	5
Rifle					"	5344	282	3·55	1668	940	....	798	1044	E 5
Musket					"	1642	...	....	....	....	....	884	987	X p 4
Rifle					"	13132	...	....	....	....	....	943	955	p 5
Sporting				Esquerades, French.	"	.....	...	....	....	....	....	955	....	French.
Cannon, uneven	75	12·5	12·5	Dupont's Mills, Delaware.	Rough.	166	153	2·09	....	....	....	758	790	F
large					"	166	152	1·91	1558	871·5	....	756	775	1
medium					"	168	196	2·95	1527	861	....	768	751	2
very large, even					"	211	200	....	1504	849	....	740	762	0
Sporting	77	13	10	Dupont's Mills, Delaware.	Highly glazed.	79808	100	4·42	1774	1000	1888	1000	1047	G 6
Blasting, uneven	70	15	15		Glazed.	295	212	....	1660	986	....	....	917	S
Cannon, medium	76	13·7	10·3	Garesché, Delaware.	"	191	216	2·60	....	....	....	754	879	B 2
Rifle	76	15	9	Loomises, Hazard & Co., Connecticut.	"	2378	204	....	....	....	....	920	984	C 5
Sporting					"	.....	...	....	....	....	....	888	....	6
Cannon, uneven	75	15	10	Waltham Abbey, England.	"	174	...	....	....	....	....	731	872	English.
Musket					"	2502	...	....	....	....	....	841	844	"
Rifle					"	11600	...	....	....	....	....	865	820	"
Sporting	....	....	....	J. Hall & Sons, Dartford, Eng.	"	.....	...	....	....	....	....	990	....	"
Cannon, uneven	75	12·5	12·5	Bouchet, France.	Rough.	316	...	....	....	....	....	835	804	French.
Musket						2410	...	....	....	....	....	796	830	"
Musket	....	....	....	Stockholm, Sweden.	Glazed.	.....	...	....	....	....	....	742	....	Swedish.

NOTE.—The report of Capt. Mordecai embraced a greater number of specimens, and furnished other elements. A selection only has been made of such qualities of powder, results, &c., as are considered essential for general purposes.

Table showing the Increase of Weight in 1 lb. of various kinds of Gunpowder exposed to Moisture for a period of 17 days.

Kind of powder.	Increase of Weight.	Kind of powder.	Increase of Weight.	Kind of powder.	Increase of Weight.
	Per cent.		Per cent.		Per cent.
A 1	2·77	E 5	8·55	F 2	2·95
8	3·85	F	2·40	G 6	4·48
B 2	7·685	F 1	1·91		

The powders A and B were slightly caked by this exposure; E much more so; the F's were not at all caked; and the G became hard caked on the surface after 6 days' exposure.

Table showing the Relative Force, by the Musket Pendulum, of various kinds of Gunpowder in good order, and of the same Powders dried, after Exposure to Air saturated with Moisture.

Kind of powder.	Powder in good order.	Powder dried after exposure to moisture.			Loss of force by the exposure.	Gain of force by the expos're.
	Initial velocity of ball.	Moisture absorbed.	Abs'd moisture retained.	Initial velocity of ball.		
	Feet.	Per cent.	Per cent.	Feet.	Per cent.	Per cent.
A 1	1256	20·88	·93	891	29·06	....
A 4	1490	23·25	·29	1480	1·27	....
A 5	1648	27·05	·31	1516	9·08	....
E 5	1351	23·11	0·	1472	....	8·96
F 1	1404	20·83	0·	1315	6·34	....
F 0	1373	22·59	·20	1143	16·75	....
G 6	1858	19·53	0·	1472	20·49	....

The least dense powders return nearest to their original strength. The gain by the powder E 5 arose from the circumstance that the density of it in its original state was so great as to impede its combustion; hence, the grain becoming swollen by exposure to moisture, and its density correspondingly diminished, its combustibility was increased in a greater degree than its strength was impaired by the moisture.

In a large charge, like to that of a 24-pound gun, Capt. Mordecai thinks the result would not be the same.

Table showing the Loss of Force by Windage.

24-POUNDER GUN.

Powder.	Ball.	Initial velocity of ball in feet per second.			
		Without windage.	Windage ·135 inches.	Windage ·245 inches.	Windage ·355 inches.
Pounds.	Pounds.	Feet.	Feet.	Feet.	Feet.
4	24·25	1681	1430	1388	1197
6	24·25	1963	1102	1306	1465

A comparison of these results shows that 4 lbs. of powder give to a ball without windage nearly as great a velocity as is given by 6 lbs. to a ball having 0·14 inch windage, which is the true windage of a 24-pound ball; or, in other words, this windage causes a loss of nearly *one-third* of the force of the charge.

Table showing the Loss of Force by the Vent of a Gun.

24-POUNDER GUN.

Powder.	Vent.	Veloc. of ball.	Powder.	Vent.	Veloc. of ball.
Pounds.	Inches.	Feet.	Pounds.	Inches.	Feet.
3	·175	1251	6	closed.	1705
3	closed.	1250	6	·25	1625
6	·25	1696	6	·175	1627
6	·175	1702	6	closed.	1612

These experiments show that the loss of force, by the escape of gas from the vent, is altogether inconsiderable, when compared with the whole force of the charge.

Table showing the Effect of different descriptions of Wadding.

Powder.		Kind of wad.	Velocity per second.
Kind.	Weight.		
	Grains.		Feet.
G 2	77	Ball wrapped in the cartridge paper, the whole crumpled into a wad and inserted over the p'dr.	1808 1877
"	77	1 felt wad on powder and 1 on ball	1846
"	77	2 felt wads on powder and 1 on ball	1482
French sporting	77·17	1 elastic wad on powder and 1 on ball	1096 1169
"	77·17	2 pasteboard wads on powder	1200
"	77·17	2 felt wads on powder	1088
G 6	77·17	2 elastic wads on powder	1100 1079
"	77·17	2 pasteboard wads on powder	1198
"	77·17	2 felt wads on powder	1106
"	77·17	2 felt wads on powder and 1 on ball	1190
"	77·17	Ball wrapped in the cartridge paper, as in the first experiment,	1231

The *felt wads* were cut from the body of a hat, weight 3 grains.

The *pasteboard wads* were $\frac{1}{10}$ of an inch thick, weight 8 grains.

The *cartridge paper* was 3 × 4·5 inches, weight 12·82 grains.

The *elastic wads* were "Baldwin's indented," a little more than $\frac{1}{16}$ of an inch thick, weight 5·127 grains.

The most advantageous wads are those made of thick pasteboard, or of the ordinary cartridge paper.

Comparison of the Force of a Charge in various Arms, as determined by Experiments in Small Arms of Rifle Calibre.

Kind of Arm.	Lock.	Powder A 5	Windage.	Ball's Weight.	Velocity.
		Grains.	Inches.	Grains.	Feet.
Common rifle	Percussion.	100	·015	219	2018
" "	"	70	·015	219	1755
Hall's rifle*	Flint.	70	·000	219	1490
Hall's carbine*	Percussion.	70	·000	219	1240
Jenks's carbine*	"	70	·000	219	1081
Cadet's musket	Flint.	70	·045	219	1690
Pistol	Percussion.	35	·015	219·5	947

* Loaded at the breech.

PRACTICAL DEDUCTIONS OF CAPT. MORDECAI, SUGGESTED BY HIS EXPERIMENTS.

Proof of Powder.—The common eprouvettes are of no value as instruments for determining the relative force of different kinds of gunpowder.

In the proof of gunpowder a cannon pendulum should be used.

In a 24-pounder gun, new cannon powder should give, with a charge of 6 lbs., an initial velocity of not less than 1600 feet to a ball of medium weight and windage.

For the proof of powder for small arms, a small ballistic pendulum is best adapted.

The initial velocity of a musket ball (18 to the pound), of 0·05 inches windage, with a charge of 120 grains, should be:

With new musket powder, not less than 1500 feet.
With new rifle powder, not less than 1600 feet.
With fine sporting powder, not less than 1800 feet.

Manufacture of Powder.—The powder of greatest force, whether for cannon or small arms, is produced by incorporation in the "cylinder mills."

Effect of Wads.—In the service of *cannon*, heavy wads over the ball are in all respects injurious.

For the purpose of retaining the ball in its place, light *grommets* should be used.

On the other hand, it is of great importance, and especially so in the use of small arms, that there should be a good wad over the powder for developing the full force of the charge, unless, as in the rifle, the ball has but very little windage.

Effect of the Size of the Grain.—Within the limits of the difference in the size of grain, which occurs in ordinary cannon powder, the granulation appears to exercise but little influence on the force of it, unless the grain be exceedingly dense and hard.

Effect of Glazing.—Glazing is favorable to the production of the greatest force, and to the quick combustion of the grains, by affording a rapid transmission of the flame through the mass of the powder.

Effect of using Percussion Primers.—The increase of force by the use of primers, *which nearly closes the vent*, is constant and appreciable in amount, yet not of sufficient value to authorize a reduction of the charge.

Bore, Weight of Charges, and Ranges for U. S. Small Arms.

Kind of Arm.	Bore.	Windage of ball.	Powder.	Ball.
	Inches.	Inches.	Grains.	
Musket	·69	*·05	120	397·5 grains. Wad, 10·2 grs.
"	·69	†·04	110	410·2 " " 10·2 "
Rifle	·54	·025	75	218·5 " " 8·4 "
Pistol	·54	·025	35	218·5 " " 5·5 "
"	·54	·025	30	218·5 " " 5·5 "

* 0·05679 lbs., or 18 to the pound. † 0·05861 lbs., or 17 to the pound.

RANGE FOR SMALL ARMS.

Musket.—With the ball of 17 to the pound, and a charge of 110 grains of powder, &c., an elevation of 36′ is required for a range of 200 yards; and for a range of 500 yards, an elevation of 30° 30′ is necessary, and at this distance the ball will pass through a pine board 1 inch in thickness.

Rifle.—With the charge of 70 grains, an effective range of from 300 to 350 is obtained; but as 75 grains can be used without *stripping* the ball, it is deemed better to use it, to allow for accidental loss, deterioration of powder, &c.

Pistol.—With the charge of 30 grains, the ball is projected through a pine board 1 inch thick at a distance of 80 yards.

PROOF OF POWDER.

Ordinary Proof of Powder.—One oz. with a 24-pound ball. The mean range of new, proved at any one time, must not be less than 250 yards; but none ranging below 225 yards is received.

Powder in magazines that does not range over 180 yards is considered unserviceable.

Good powder averages from 280 to 300 yards; *small grain*, from 300 to 320 yards.

DIMENSIONS OF POWDER BARRELS.

Whole length	20·5 inches.
Length, interior in the clear	18· "
Interior diameter at the head	14· "
" " bilge	16· "
Thickness of staves and heads	·5 "
Weight of barrels, about	25 lbs.

◆

On Longitudinal Compression of Materials.

Results of Late Experiments upon the Resistance to Compression of various Substances of the Dimensions of one Cubic Inch.

Materials.	Weight in lbs.	Materials.	Weight in lbs.	Loss by freezing in 10·000 of an oz.
METALS.		STONES, &c.		
Cast-iron, gun metal	146·000	Granite, Patapsco	11·200	
Wrought-iron	116·000	*Sandstone, Aquia Creek	5·340	
begins to yield	40·000	† " Seneca	10·764	
Brass, fine	164·800	" Aquia Creek, strata laid horizontally,	8·302	
Copper, cast	117·000	‡Marble, Stockbridge	10·382	8·8
Tin, cast	15·500	§ " East Chester	23·917	6·2
Lead	7·730	‖ " Symington, large crystals	11·156	
WOODS.		" same, strata horizontal	10·124	
Oak	4·500	" same, strata vertical	9·124	
Pine	1·930	" same, fine crystals	18·248	
Elm	1·290	" Italian	12·624	
STONES, &C.		" Lee, Mass.	22·702	9·9
Gneiss	19·650	" Hastings, N. Y.	18·941	11·8
Brick, hard	4·368	" Montgomery Co., Penn.,	8·950	8·8
common	4·000	" Baltimore, large crystal	8·057	21·9
fire	[illegible]	" " small crystal	18·061	8·1

* Same as that of the Capitol, Treasury Department, and Patent Office, Washington.
† " " " Smithsonian Institute.
‡ " " " City Hall, New York.
§ " " " General Post-Office, Washington.
‖ " " " National Washington Monument.

Resistance of Stones, &c., to the Effects of Freezing.—Various experiments show that the power of stones, &c., to resist the effects of freezing, is a fair exponent of that to resist compression.

◆

Experimental Investigation of the Principles of Locomotive Boilers.

From the proceedings of the London Institution of Civil Engineers, reported in the Civil Engineer and Architect's Journal, we extract the following sketch of a paper read before that body by Daniel K. Clark, of Edinburgh.

March 8.—The paper commenced with some historical facts in locomotive progress; showing that the general design of the locomotive was matured immediately after the trials on the Liverpool and Manchester Railway in 1829—combining the multitubular horizontal boiler, the horizontal cylinders, and the blast-pipe. Reference was made to the various systems practised in working out the general design, and to the necessity for fixed principles in proportioning the locomotive to the work for which it was destined. For the proper discussion of the question it was indispensable to distinguish the three elements of the machine—the boiler, the engine, and the carriage; and to consider them separately, with respect to their proper functions, as the mixing up of one with the other had caused much of the confusion with which many of the recent discussions on the subject had been invested.

The paper was chiefly devoted to the discussion of the physiological principles of locomotive boilers. It was argued that the combustion of coke in the firebox was, in practice, very completely effected; that it was quite independent of the strength of the draught, being equally complete with fast and slow draughts; that expedients for improving the combustion were superfluous; and that the combustion of coal might also in practice be perfected by a judicious use of the ashpan, damper, and the firedoor. The evaporation of 12 lb. of water per pound of pure coke was found, by careful laboratory experiments, to be the maximum evaporative performance; in the best ordinary practice an actual evaporation of 9 lb. of water per pound of coak, or 75 per cent. of the possible maximum, was readily obtained, the balance being lost by leakage of air and by waste; and it was adopted by the author as the ordinary standard of practical economical evaporation.

It was shown, by numerous examples, that the question of the relative value of firebox and tube surface was of no practical importance, as the efficiency of boilers was not sensibly effected by their relative amounts; that the superiority of firebox surface was due merely to its greater proximity to the fire; and that the distinction of radiant and communicated heat was merely circumstantial—that what was gained in radiant heat was lost in communicated heat, and that whether it was all radiating, or all communicated, mattered not to the total efficiency of the fuel. On these grounds, the author regarded with indifference the use of such expedients as extended fireboxes, midfeathers, corrugated plates, and combustion-chambers; and it was asserted, that where the addition of midfeathers had been found advantageous, there had been a deficiency or malarrangement of the tube-surface.

A minute analysis was made of the results of numerous authenticated experiments on the evaporative power of locomotive boilers, of very various proportions, comprising several made by the author on the engines of the Caledonian, Edinburgh, and Glasgow, and Glasgow and Southwestern Railways. It was concluded, that the economical evaporative power of boilers was materially affected by the area of the fire-grate, and by its ratio to the whole heating surface; that an enlargement of the grate had the effect of reducing the economical evaporative power, not necessarily affecting the quality of combustion in any way, but governing the absorbing power of the boiler, as the lower rate of combustion per foot of grate due to a larger area, in burning the same total quantity of fuel per hour, was accompanied by a reduced intensity of combustion, and by a less rapid transmission of heat to the water, in consequence of which a greater quantity of unabsorbed heat must escape by the chimney. An increase of heating surface again, reduced the waste of heat, promoted economy of fuel, and added greatly to the economical evaporative power. In short, the question resolved itself into the mutual adjustment of three elements—the necessary rate of evaporation, the great area, and the heating surface, consistent with the economical generation of steam at the assumed practical standard of 9 lb. of water per pound of good coke. An investigation of the cases of economical evaporation, in the "Table of Experiments," conducted the author to the following important equation, expressing the relation of the three elements of boiler-power; in which e was the maximum economical evaporation, in feet of water per foot of grate per hour; h was the total heating surface in square feet, measured inside; and g was the grate-area in square feet:

$$e = \cdot 00222 \frac{h^2}{g}$$

From this it followed: 1st, that the economical evaporative power decreased directly as the area of grate was increased, even while the heating surface remained the same; 2d, that it increased directly as the square of the heating surface, when the grate remained the same; 3d, that the necessary heating surface increased only as the square-root of the economical evaporative power; 4th, that the heating surface must be increased as the square root of the grate-area, for a given economical evaporative power. It was contended thence, that the heating surface would be economically weakened by an extension of the grate, and would be strengthened by its reduction; and that whereas large grates were commonly thought to be an unmixed good, and being generally recommended were usually adopted, still they might be made too large—not that their extension affected the quality of combustion, but that the economical evaporative power might be reduced. Concentrated and rapid combustion was alike the true practice for the largest and the smallest boilers; and, in locomotives where lightness, compactness, and efficiency were primary objects, the boilers should be designed for the highest average rates of evaporation per foot of grate that might be followed in good practice, consistently with the highest average rate at which coke could be properly consumed; as, in this manner, the smallest grate and the smallest amount of heating surface consistent with good practice might be employed. It was stated that 150 lb. to 160 lb. of good sound coke could be consumed per foot of grate per hour; and, allowing for inferior fuel, an average maximum of 112 lb. per foot of grate per hour was recommended as a general datum. This determined the average maximum of economical evaporation to be 16 feet of water per foot of grate per hour, allowing 9 lb. of water per pound of coke; for which 85 feet of heating surface per foot of grate should be provided. It was accordingly recommended that a heating surface at least 85 times the grate-area should be adopted in practice.

It was also shown, by examples of inferior economy of evaporation, that the clearance between the tubes, for the circulation of water and steam, was in many boilers much too small; that the clearance should be in proportion to the number of the tubes, and that for good practice a clearance at the rate of ¼ inch for every 30 tubes should be allowed. The author supplied several practical rules deduced from this examination, and stated his conviction that the deductions from his experience with locomotive boilers were in the main applicable to all other forms of boiler. He applied the rules to several conspicuous examples of locomotive boilers of the present day, and endeavored to show in what respects they were defective; he also suggested simple means of rectifying them and of improving their action; and alluded to the long boiler (of Stephenson) as affording the best example of combined lightness, compactness, and evaporative power.

The author finally referred to his practical investigations on the subject of the blast-pipe; from these he concluded that in all practical cases the blast-pipe was susceptible, by a correct adjustment of the details of the boiler, of being made abundantly wide enough, consistently with the demands for steam, to afford a free and sufficient exhaust at all speeds, so as practically to remove all back pressure by imperfect exhaustion.

March 15 *and* 22.—Both evenings were entirely devoted to the discussion of Mr. Clark's paper.

The author's deductions were admitted as to the practical identity of firebox and tube surface for evaporating action, and as to the constancy of the evaporative efficiency of fuel; whether by radiant or communicated heat, or both together, or whether the draught was mild or strong. It was considered that heat was specific and certain in its effects. Such expedients as "midfeathers," &c., which were resorted to for specially increasing the firebox surface, were condemned, as they were considered to be no better than tubes, whilst practically they were inconvenient and costly; as, among other reasons, plates of $\frac{7}{16}$ inch or ½ inch in thickness were employed to do the work of the tubes, which were less than ⅜ inch in thickness.

A practical rule followed by some engineers, and stated to be founded on extensive experience, was to allow 5 feet of heating surface for 1 foot of water evaporated per hour, and 100 feet of evaporating surface per square foot of grate. Those results were found to agree with the maximum rates recommended in the paper. It was also argued that the intensity of combustion materially affected the amount of heating surface necessary for economical evaporation, being less as the intensity was greater. It was contended, on the other hand, that the formula as stated in the paper would not apply to all engines, and the following table of actual results was given, showing the performance of various engines, several of which exhibited a greater and others a less evaporation of water, and consumption of coke, per square foot of grate surface per hour than the formula would have given.

*Actual Working Results of Engines, Compared with Deductions by the Formula.**

Name or No. of Engine.	Total Heating Surface.	Total Firegrate Surface.	No. of Carriages.	Speed per Hour.	Actual Evaporation per Square Foot per Hour.	Evaporation by Clark's Formula.	Actual Coke Consumption per Square Foot per Hour.	Coke Consumption by Clark's Formula.	Per Centage of Difference in Water.	Per Centage of Difference in Coke.	Date and Name of Observer.
234	1125	14·82	12·8	26·5	5·41	16·05	44·9	126·3	180	188	From March 10th to 12th, both inclusive—Mr. Alexander.
291 1st Experiment	1325·8	18·8	9	42·1	4·72	11·04	40·8	116·5	175	190	24 February—Mr. Forsyth.
291 2d Experiment	1325·8	18·8	17	38	5·12	11·04	58·48	102·7	120	76	7 March—Mr. Alexander.
300	1133·21	23·5	34	36.4	8·21	5·16	65·5	40·37	60	62	8 March—Mr. Forsyth.
Rocket—1st Experiment	707	10·6	9	42·1	8·99	9·89	78·4	86·2	12	10	24 February—Mr. Alexander.
Rocket—2d Experiment	707	10·6	18	84·5	11·9	9·89	102·3	84·4	22	21	25 February—Mr. Alexander.
Heron and Prince of Wales	707·54	10·6	34	84·5	10·68	9·89	72·1	73·7	11	10	8 March—Mr. Alexander.

It was further argued that, from various causes, no formula could be framed to be of service unless all the circumstances in each case were properly taken into account.

As an example of the objections to long tubes, the results were given of the work done by a luggage engine on the London and Northwestern Railway, before and after alteration. That engine originally had tubes 14 feet long, with a total surface of upwards of 800 feet; the length of the tubes was diminished to 4 ft. 9 in., and the total surface was reduced to about 500 feet, when it was found that a saving in fuel of 40 per cent. per ton per mile moved was produced, with a saving of 23 per cent. per mile run; the coke used per ton per mile, with long tubes before alteration, being ·504 lb., and with the short tubes ·298 lb.

The back pressure was contended to be a serious drawback to the long-tube engine, and an example was given of a trial of a single engine on the new plan, against two of the ordinary kind, with a load of 170 tons in both casts, and, although the single engine was 43 per cent. less powerful than the two engines together, and had 20 per cent. less heating surface, yet it had performed the same distance of 111 miles in ten minutes less time, and with 3 lb. per mile less fuel. This, it was argued, was owing to the engine exerting a greater dynamic force, by being relieved from the back pressure of the blast-pipe, which in the case of the other two was applied to force the fire, and to draw the heated air through the long tubes.

By the mode of placing the tube plate some distance within the cylindrical part of the boiler, the tubes were not liable to be choked with cinders, or the draught to be obstructed. This plan also afforded an opportunity of reducing the size of the tubes from 1¾ inch diameter to 1⅜ inch, giving in the same boiler an equal area of flue passage, whilst at the same time the proportion of tube heating surface was increased 34 per cent. per foot of length of tube, and a very large addition of flame surface was gained.

It was further argued that although the evaporation of water per lb. of fuel was the test of the boiler, yet, up to this time, few if any experiments could be implicitly relied upon, owing to the quantities being estimated by measurement instead of by weight, and without due regard to the variation of the temperature of the water in the tender.

As to the evaporative powers of marine boilers as compared with that of the best locomotive boilers, if an investigation was instituted it would be found that the general features of the best tubular marine boilers now used in ocean navigation were nearly identical with those of locomotive boilers, but the circumstances under which they were used were very different. In the marine boilers, coal was used instead of coke, and the natural draught of the chimney instead of the urging of the blast-pipe in a locomotive; salt water was also used, instead of fresh water, and a pressure of about 12 lb. or 14 lb. instead of from 60 lb. to 80 lb. on the square inch. Although lightness and compactness were important properties in marine boilers, they were less so than in locomotives, and the former were frequently worked for many weeks or months consecutively, without the means of stopping for any extensive repair, or even to be cleaned except at long intervals. Under these circumstances marine boilers required to be worked less intensely, and the water and flue spaces must of necessity be larger, to prevent their being choked up. The following statement showed the comparative proportions and effect of the two descriptions of boilers:

In the Locomotive Boiler	*In the Marine Boiler*
1 square foot of firegrate consumed about 112 lb. of coke per hour.	1 square foot of firegrate consumed about 20 lb. of coal per hour.
1 square foot of firegrate required about 85 square feet of firebox and tube surface.	1 square foot of firegrate required about 30 square feet of fireplace and tube surface.
1 square foot of firegrate with the above surface, would evaporate 1008 lb. of water per hour.	1 square foot of firegrate with the above surface would evaporate 170 lb. of water per hour.
1 square foot of flue surface would evaporate 11·7 lb. of water per hour.	1 square foot of flue surface would evaporate 5·66 lb. of water per hour.
1 lb. of coke would evaporate 9 lb. of water.	1 lb. of coal would evaporate 8·5 lb. of water.
1 H. P. of 33,000 lb. lifted 1 foot high per minute, required about 4 lb. of coke per hour.	1 H. P. of 33,000 lb. lifted 1 foot high per minute, required about 4·25 lb. of coal per hour.

From this statement it appeared that although the proportion between the firegrate and the flue surfaces was widely different, the quantity of water evaporated, and the power obtained by the consumption of a given weight of fuel, was nearly the same, when allowance was made for the difference in the evaporative power of coal and coke.

After explaining the table of "working results," &c., it was contended that in no case did the formula accord entirely with the practical results recorded in the table; the nearest approximation being that of the "Rocket."

It had been found, in the altered goods-engine, that certain practical inconveniences arose from the horizontal transverse water-tubes, and two or three midfeathers had now been substituted for them.

It had been found, that intense combustion was liable to cause the formation of clinkers in the small firebox, but which did not occur in the new engine. When the drivers first took out the new engine, being unaccustomed to its peculiar action, they kept thin fires, and drew too much air through the fuel, which was wasted by raising steam too freely; latterly, the fires had been kept thicker, and the combustion had been slower, whilst the supply of steam had been fully equal to all demands upon the engine, which, it should be recollected, had been built expressly for conveying heavy loads at high speeds, and whose performances under these circumstances were contended to have been among the best recorded results of the present day. To set at rest all questions as to duty performed, it was proposed to institute a set of experiments, or trials, with certain loads at given speeds; the tests to be "consumption of coke per ton per mile, and time of performance." The results to be communicated to the Institution.

The possible maximum evaporative power of 1 lb. of carbon, was deduced from the results of chemical experiments, showing that 1 lb. of carbon, converted into carbonic acid, developed 14,000 units of heat, or would raise 14,000 lb. of water through 1°, which was equivalent to the conversion of 12 lb. of water at 60° into steam of 120 lb.

The formula was shown to be derived directly from the tabulated results; it was a mere embodiment of results, and represented no theory. It was explained that the formula referred to the economical evaporative power of boilers, and that it was in no way designed to limit the unconditional evaporative power; that a boiler might raise less or more steam than the quantity assigned by the formula, but that, in the latter case, it could only do so by a partial sacrifice of the fuel.

In the comparative trials of the Crewe engines and the new engine, with enlarged firebox, it was shown that looking simply to the boilers, the Crewe boilers raised a greater total quantity of water per hour, and more water per foot of grate per hour, than the new boiler, with greater economy, in the ratio of 8¼ lb. per lb. of coke by the Crewe boiler, to 7¾ lb. by the new boiler. It was explained, with respect to the greater time lost by the Crewe engines on trial, that the defect lay, not in the boilers, but in the exposed position and unprotected state of the cylinders, by which steam was condensed, and in the too large size of the chimneys, which should have been only 12 inches instead of 15 inches diameter, and in the blast-pipe, which was carried too far into the chimney.

The formula being applied to the new boiler, indicated that it could not economically evaporate above 120 cubic feet of water per hour; and the correctness of this indication was confirmed by the result of eighteen experiments by Mr. Marshall, as they showed that though 150 feet of water per hour had been evaporated, it was at a sacrifice of one-fourth of the fuel, as only 7½ lb. were evaporated per pound of coke.

With respect to the rapidity with which the new form of boiler could get up the steam, and which was attributed to the free draught, it was shown that the "Rocket," the first tube-boiler engine ever made, got up the steam in less time than the new boiler. The benefit of the removal of the tube-ends in the new boiler, from the direct action of the fire, was considered to be more than balanced by the liability of the lower part of the combustion-chamber to become overheated and to be burned away, owing to the lodging of steam at the junction with the firebox. It was suggested that in order to obtain better results from the new engine, the combustion-chamber should be abolished, the number of the tubes should be reduced, and their length be extended to the firebox, which should be restricted to 16 square feet of area.

It was further argued, that in the statement of "Actual working results," &c., the formula had been misunderstood and wrongly applied; for instance, in the two Crewe engines, of identical proportions, the results of the formula were stated as 86·2, 84·4, and 73·7, whereas the same results ought to have been applied to each. In No. 291 engine a similar discrepancy was apparent, the results being 116·5 and 102·7. In the experiments themselves there were several unexplained anomalies, and in some instances the engines instead of working at their full power, were performing very inadequate duty, and therefore under circumstances to which the formula was not intended to apply.

In the case of the altered goods-engine, No. 125, it was urged that in its original state, the engine must have been either in a very inefficient condition, or that its duty must have been chiefly confined to piloting, when it would have been consuming the fuel without producing any useful effect, as a consumption of 51 lb. or 58 lb. per mile run, with an average train of 115 tons, was out of all proportion. That the result of the working after alteration, viz., a consumption of 39 lb. and 43 lb. per mile run, with a load of 144 tons, was not favorable, as compared with the performance of a narrow-gage engine reported on by Mr. D. Gooch in the Gage Inquiry, where, with a consumption of 47 lb. per mile, a load of 294 tons was conveyed. Also, when compared with the working of the Eastern Counties goods-engines for the last half-year, where, with an average load exceeding 170 tons, the consumption of coke was only 32 lb. per mile, taken over a distance of 529,000 miles.

A comparison was drawn between the recent experiments by Mr. Marshall, on the large firebox engine, and those on the long boiler engine, made during the Gage Inquiry, the results being with the former a consumption of 40 lb. per mile with an average load of 64 tons, and with the latter a consumption of 27 lb. per mile with a load of nearly 60 tons. The recorded results of the work of the passenger trains on the Eastern Counties line, for the last half-year, showed an average consumption of coke under 18 lb. per mile run.

It was contended, that hitherto no advantages had resulted from the extension of the firebox and the reduction of the length of the tubes, still it was possible that this innovation might, by directing attention to the subject, lead to important modifications of the structure of locomotive boilers, which should possess compactness, lightness, power of raising sufficient steam with rapidity, for performing the required work, strength to resist the chance of explosions, and a form calculated to diminish the disastrous effects of explosions when they occurred, facility of repair, especially of the firebox, which was the part most liable to deterioration, being most severely acted on by the fire, and also requiring more support than the tubes, the latter being at the same time cheaper and of thinner metal, whilst by an extension of their length the diameter of the external shell of the boiler could be diminished; the firegrate should not be larger than would evaporate the required quantity of water in steam, within a given time, with the utmost practical economy of fuel, and if that were accomplished it was of little importance whether the evaporating heat was communicated through the firebox, or by the tube surface. As to the midfeathers, it was contended they had hitherto only served to extend the dimensions of the firebox, and to increase the difficulties of maintaining and repairing the boiler; and that up to the present time the results of the experiments upon the boiler with enlarged firebox and shortened tubes, exhibited rather a retrograde step than an onward progressive movement.

[From the Paris Correspondence of Silliman's Journal.]

Experiments in Novel Engines in France.

Caloric Engine.—The use of hot air as a motive power in place of steam has been the general topic of conversation among men of intelligence, since the attention directed to the subject by accounts in the American papers of the experiments of Captain Ericsson. Reclamations flow into the Academy of Sciences, not for priority as to the idea of employing hot air for producing motion, an old principle, and of unknown origin,* but for the use of a metallic network for saving or storing the heat. This idea appears to have occurred independently to Captain Ericsson, MM. Franchot, Lemoine, and Lobereau, who, unknown to one another, have applied it in the construction of machines; it is evidence of their good faith in the question that they have each patented their inventions, which they would not have ventured to have done, if they had been aware of previous inventions of the kind.

M. Burdin, mining engineer, brought out a machine of another kind, using in place of a metallic network, a column of sand, which without doubt is less effectual. He was occupied in the construction of a machine of 8 to 10 horse-power, on this basis, when the revolution of February changed the nature of his labors.

The priority, so much disputed, appears at present to belong to M. Franchot,† as well as to Captain Ericsson, for the latter does not date his title anterior to 1838, which is the same period with the patent of M. Franchot.‡

A machine of this kind constructed by M. Franchot was submitted in 1840 to a commission named by the Academy of Sciences, composed of MM. Poncelet, Séguier, Coriolis, Savary, and Pouillet, and it was put in operation before these judges. M. Pouillet, who was charged with reporting on the engine, used his efforts towards burying the memoir of M. Franchot in the "cartons" of the Academy, with his usual aversion to innovations in general; an aversion which he exhibited before the full Chamber of Deputies, with reference to the Electric Telegraph, speaking of it as Utopian and chimerical, at a time when this admirable invention was already in successful action in the United States.

We do not describe here this machine, as it has only an historical interest, for it does not equal in any respect that of Captain Ericsson. It has been claimed for Ericsson's machine that it realizes an economy of 95 per cent., and in consequence of this exaggeration, some persons have fallen into the opposite extreme, and have strongly argued before the Academy of Sciences, and the Société d'Encouragement, that the saving is actually nothing, and that the regenerator instead of being an aid, is a hindrance in the machine, such persons alleging that the greater part of the heat is lost in the state of latent heat, and that there is a set-off for the rest in the resistance which the metallic network offers to the passage outward of the hot air.

MM. Galy-Cazalat and Liais, who have come out as the opponents of Ericsson's invention, do not appear to understand the true use of the regenerator, to which they attribute a uniform temperature after the column of hot air has deposited there its caloric, and deny wholly its value. They might as well deny the possibility of bringing into use the currents of air which escape from a furnace. Besides, these writers calculate that the 155 square meters of wire network in the regenerator must weigh 15,000 kilograms, amounting to 90 kilograms the square meter. But little experience is needed to show that this is not so; a square meter of wire network of 65 wires to the inch weighs barely one kilogram. There is more than one mistake in the memoir of M. Galy-Cazalat; and M. Liais errs in like manner. It is to be noted that both of these mechanicians have constructed hot-air engines which they claim will operate economically without a regenerator. M. Galy-Cazalat concludes by advising Captain Ericsson to do away with the regenerator, and give, per horse-power, 40 square decimeters to the surface heated. "This surface in the caloric engine," says he, "is so small and so highly heated that it allows two-thirds of the heat to escape uselessly into the atmosphere; so that the economy due to the regenerator, were it real, should be reckoned only with reference to the one-third of the combustible usefully employed." One passage in this memoir meets with general and hearty approbation. "As regards the interests of mechanics, all mechanicians are vastly indebted to Mr. Ericsson and the capitalists who have seconded his efforts. Whatever the result, to Captain Ericsson belongs the honor of having made the first great successful attempt in substituting hot air for steam, in a vessel of the first class."

Engine, using the vapor of water at a high temperature.—The magnificent experiment in the bay of New York has excited special attention in France to the subject of motors in general. Some important facts have come to light within a few weeks, which deserve mention.

The use of the vapor of water at a high temperature has been the subject of extended researches, and its application in the production of motion has been attempted both for stationary and locomotive engines. Whilst I was experimenting on the Lyons railroad upon the magnetic adherence of the wheels and rails, there was a trial being made at the same time with a locomotive moved by super-calorized steam, the plan of which is still kept secret; and it was afterwards abandoned for the same reason that had led Séguier to lay aside his enterprise of a similar kind, who, on constructing a steamboat to be thus moved, was frustrated by the rapid destruction of the tubes of copper which supplied the steam. M. Belleville of Nancy has taken up this subject, according to MM. Séguier and Jobard, and has met with complete success; the machine constructed by him worked for five weeks at Labriche, near Paris, having been substituted for a steam-engine of 29 horse-power, with a saving of 40 per cent.

Chemists will be surprised to learn that M. Belleville owes his success to the use of iron for the pipes alluded to. The drawing of this metal into pipes of a certain length—a recent invention by M. Gandillot—has come to the assistance of M. Belleville; and the iron is so perfectly soldered as to resist the strongest pressure.

"To create vapor in like manner as it is destroyed in the worm of a still," says M. Séguier, "was one of the most important problems to be resolved in the present state of science." There is also one other, which is, that of employing vapor directly, without an intervening medium.

Much labor has been spent upon the study of reaction, and the known principle that reaction equals action. But that which is incontestable as a principle, has not yet been established by practice. The invention of M. Belleville will contribute greatly to this end, owing to the facility and the safety with which he is enabled to produce vapors at pressures exceedingly elevated. It appears that M. Jobard only awaits the result, in order to carry out an idea of this kind which he has had under contemplation for several years.

It is evident that by the direct use of steam and the worm of M. Belleville, the steam-engine will not occupy one-tenth the space, nor have a tenth part of the weight, nor cost as much by one-tenth, as the ordinary engine.

It appears that the human mind cannot arrive at simplicity except by passing through the complex; it is like a mountain more or less elevated, whose heights must be overcome before the plain at the opposite base can be reached: and when reached, the level seems to be that of the plain left behind. So when a simple solution of a problem is arrived at, we think it an easy natural thought and almost self-evident.

Engine of M. Beauregard.—These views have for a long time been defended by M. Moigno, with especial reference to a machine for super-calorized vapor by M. T. de Beauregard, based on the principle of the *spheroidal state*, discovered by M. Boutigny, and which has led to the invention of an engine of small power which is constantly at work in the manufactory of sperm candles of MM. Jaillon, Moinier & Co., at Lavillette near Paris.

The peculiarity of this engine consists in the boiler, Fig. 1, which is a cylinder, hemispherically cup-shaped below, having above a cover bolted down, and furnished with all the ordinary apparatus of a steam-engine: a supply-tube, A; steam-pipe for the steam, V; blowing-off pipe, P; a steam-gage, M; safety-valve, S; escape-pipe for excess of steam, placed at T on the tube which supplies the steam or vapor to the engine. The cylinder contains within 5 to 7 diaphragms, the borders of which are bent upwards; they are alternately convex and concave and pierced with small holes from below upwards. By this arrangement, the water passes over a large surface to arrive at the bottom of the cylinder, where it enters the spheroidal state. It falls like rain from the first diaphragm to the second, from the second to the third, and so on. Besides, on the first diaphragm, which is convex, the water goes from the centre to the circumference; on the second, from the circumference to the centre, &c., so that it passes over the largest possible surface, which is further augmented in extent by the small holes. The diaphragms are kept at the right distance apart by rods of iron.

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* In 1806 the Brothers Niepce, afterwards inventors of the daguerreotype, presented to the Academy of Sciences an apparatus which they called a *pyreolophorus*, in which air strongly heated produced the effect of steam. It was the subject of a commendatory report by Berthollet and Carnot.—N.

† M. Franchot was the originator of the electro-magnetic pendulum, and also inventor of the lamps called "moderator," which have brought in a short time some millions of francs to the successful speculator, who has appropriated to himself the patent of the inventor.—N.

‡ We learn that Ericsson's patent dates as far back as 1833.—Eds.

Fig. 1.

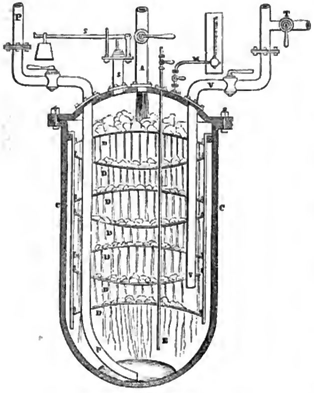
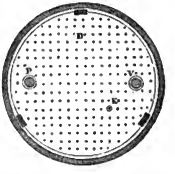


Fig. 2.



The steam is taken from between the last diaphragm and the preceding, counting from the top. This arrangement tends to establish an equilibrium of temperature between all parts of the cylinder, and to give uniformly to the steam the tension desired. The usual pressure in the boiler is 5 to 10 atmospheres.

In bringing the generator into action, it is heated dry for some minutes; then by means of a hand-pump, a few glasses of water are thrown into the boiler, the steam-gage being put in connection, and 25 minutes afterwards, the engine is brought into action which feeds thence the boiler.

In an experiment continued for 9 hours, 351 kilograms of water were evaporated, whose initial temperature was 39° C. The coal consumed was 81 kilograms; pressure produced 10 atmospheres. This pressure supposes a temperature of about 181° C., and since, according to Baudrimont, iron possesses its greatest tenacity at near 200° C., this temperature tends to increase the resistance of the sides of the boiler, instead of proving unfavorable to it.

M. Boutigny, who has detected through his researches on the spheroidal state, one of the causes of the explosions of steam-engines, has studied with care the chances of accident to which the boiler of his invention is exposed. He recognizes the following.

1. The decomposition of water by the red-hot metal.

2. Excess or deficiency in the supply for the boiler. As to the first, if it takes place, there is actually no increase in the volume of the vapor; 6 volumes of steam ($3H^2O$) *plus* 2 of iron (Fe^2), give $6H+Fe^2O^3$.

As to the second, it is apparent that the vapor will decrease rapidly as the supply is suspended, and the danger will thus be averted. But it may be feared that the bottom of the boiler being no longer supplied with water will redden strongly; and that when water is admitted, this water, spheroidalized at first, will abruptly lose its spheroidal condition from the lowering of the temperature by the continued accession of water, and so by sudden evaporation, produce an explosion—a result that happens under certain conditions in ordinary steam-boilers. The fear of such a catastrophe is dissipated on inspecting Fig. 1, where it is seen that the water falls and evaporates in the diaphragms which are not exposed to a red heat; in consequence of this evaporation, the equilibrium of temperature will be promptly re-established and all danger disappear. M. Boutigny has assured me that he has several times exposed the engine to the worst conditions, without producing either of the accidents mentioned.

Engine of M. Andrand, called Electro-caloric.—In 1844, after several preparatory trials, M. Andrand put in action on the railroad from Paris to Versailles an air-locomotive, in the presence of a commission named by government. Although with some points of resemblance, it was not precisely a caloric engine like that of Ericsson, against whom M. Andrand enters no claim of priority. The locomotive acted through air at first compressed in a heater and then dilated by the heat. The air acted at high pressure and the generator consisted of a worm plunged in a fire for the purpose; on passing through this spiral tube, the air was dilated, then on reaching the motor cylinders it underwent additional dilation, for the concave bottom of the cylinders were furnished with plates of cast-iron, which were at a white heat.

The dilatation thus obtained increased three-fold, according to M. Andrand, the power of the condensed air; whence he concluded that in order to arrive at a practical solution of the problem, the previous compression could be dispensed with, and obtain at the same time the condensation of the air by using for this purpose part of the expansive force of the caloric.

M. Andrand has not put this idea into practice. But in the course of his trials he has several times remarked an unexpected fact which we here mention.

Before making his air-locomotive public, M. Andrand had had it in operation within his workshop. When the reservoir was well filled with condensed air, the fire of the dilatator was made and the iron plates of the bottom of the cylinders were brought to a white heat. This done, it was only necessary to open the stop-cock of the reservoir to set the machine in motion, and cause the two driving-wheels to revolve. But while the apparatus was heating up, and before the valve was opened, it happened several times that the machine started spontaneously and communicated to the two wheels a frightful velocity. The phenomena continued from 30 to 40 seconds, then ceased, without his discovering how it was produced or why it stopped. M. Andrand has not succeeded in repeating it at will. Already, some three years before, the same motion, spontaneous and violent, manifested itself two or three times in a small hot-air car which this mechanician had made to move on rails.

What may be the cause of this singular phenomenon? Those who explain every thing by a word, who know the precise cause of the cholera, steamboat explosions, the potato-disease, &c., do not fail to reply that the cause is "electricity," and without looking much to the why or the wherefore, they can easily solve many other difficult problems in the same way. M. Andrand, who has, as a mechanician, a well-merited reputation, must have had recourse to the wisdom of one of these Œdipi, for he does not hesitate to make the cause "electricity."

We add, however, that M. Andrand's explanation is not without a shadow of foundation. The two motor cylinders which act independently on the driving-wheels, are of different kinds, one wholly of bronze, the other, by chance, partly of cast-iron and partly of bronze. But the phenomenon does not appear to be produced in this last cylinder, and never in the cylinder of one metal.

The two cylinders of the locomotive, in which the spontaneous movement was reproduced, also consisted of two metals, the cylinders being of cast-iron, and the pistons and bottom of bronze. From this to the phenomena of Galvani, is but a single step; and M. Andrand is convinced that he has been witness of the mechanical work of the electricity excited by the heat.

Setting aside an explanation which, elucidates nothing, and which may mischievously make one believe that the problem is resolved when it is hardly presented, we may conclude with M. Andrand, who says: It will be a conquest, both scientific and industrial, of the first order, when we shall succeed in producing at will this new motive force, and give it a continued action; then two ordinary motor cylinders, moderately heated and fed successively with a very small quantity of air dry or moist perhaps, will suffice to generate an enormous force, which M. Andrand estimates at 10 or 12 atmospheres, and this with an expense of heat which is altogether insignificant. We shall have then, says he, *electro-caloric* engines which shall leave far behind steam-engines, however perfect, and shall realize under volumes of small extent, the marvels attributed to the apparatus of M. Ericsson.

Finally, M. Andrand closes his voluminous memoir by the following considerations. "Steam-boilers are found, as regards electricity, in conditions analogous to those of our hot-air chambers; it is probable even, that with equal volumes, they contain a much larger quantity. Is it not natural that the phenomena which I have observed, as a matter of chance, in our hot-air cylinders, should be sometimes reproduced in steam-boilers?

"It is known that explosions are more violent, the greater the amount of electricity; and on the other hand, that the quantity of electricity is greatest when the steam is of moderate tension, as in steamboats of low-pressure engines. And these low-pressure engines are the ones which often explode, while the locomotives which are high pressure, very seldom explode." In support of these considerations, M. Andrand says that he has more than twenty times tried to burst vessels of thin sheet-iron by compressing in it air at a high temperature, and has not been able to succeed except in tearing them when the pressure was raised to 50 or 60 atmospheres; twice only has he produced an explosion; and these with vessels of copper when other metals were present.

Paddle-Wheel Steamers in the British Navy.*

Name of Ship.	Tonnage.	Kind of Engine.	Maker of Engine.	Nominal Power.	Diameter of Cylinder.	Length of Stroke.		Kind of Boiler.	Boiler Pressure.	Kind of Slide.	Stowage of Coals.	Kind of Wheel.	Revolutions per minute.	Diameter of Wheel.	
					in.	ft.	in.				tons.			ft.	in.
Acheron	760	Side-lever	Seaward	160	49	4	9	Flue	5	Seaward's	180	Common	19	20	0
Advice	240	Ditto	Boulton and Watt	60	35½	3	6	Ditto	8	Long D	...	Ditto	27	14	0
Alban	250	Ditto	Ditto	100	39½	3	6	Ditto	4	Ditto	50	Ditto	23	14	0
Albert (Iron)	....	Ditto	Fawcett	70	...	3	6	....	..	....	...	Ditto	23	14	7
Alecto	800	Direct	Seaward	200	...	4	6	....	..	Seaward's	...	Ditto	14	21	11
Antelope (Iron)	620	Oscillating	Penn	260	64	4	6	Tubular	10	Locomotive	186	Ditto Single Boss	26	20	0
Asp	112	....	....	50	...	2	6	....	..	....	...	....	33	10	0
Avon	361	Side-lever	Boulton and Watt	170	...	....		....	..	Short D	...	Common	16	18	2
African	280	Ditto	Mandslay	90	...	3	6	Flue	4	Long D	...	Ditto	27	14	0
Adder	....	Ditto	Boulton and Watt	120	...	3	6	....	..	Ditto	...	Ditto	29	14	0
Ardent	800	Direct	Seaward	200	...	4	6	Tubular	..	Seaward's	...	Ditto	18½	20	9
Ariel	70	Side-lever	Boulton and Watt	...	...	3	0	....	..	Long D	...	Ditto	31	12	1
Banshee	650	Oscillating	Penn	350	...	....		Tubular	..	Locomotive	...	Morgan's	..	....	
Basilisk	1000	Ditto	Miller and Ravenhill	400	...	5	0	....	..	....	...	....	..	....	
Bee	88	Side-lever	Mandslay	10	20	2	0	Tubular	10	Long D	2½	Common	40	9	0
Birkenhead	1440	Ditto	Forester	560	85	7	0	Ditto	6	....	500	Ditto	16	30	0
Black Eagle	500	Oscillating	Penn	260	...	4	6	Ditto	..	Locomotive	...	Morgan's	28½	20	3
Bloodhound (Iron)	370	Side-lever	Napier	150	...	4	0	Ditto	..	Long D	...	Common	24	16	9
Blazer	500	Ditto	Miller and Ravenhill	168	...	3	6	...	..	....	...	Ditto	23½	14	8
Bulldog	1125	Direct	Rennie	500	85	5	6	Tubular	6½	Locomotive	296	Ditto	15	26	6
Caradoc (Iron)	650	Ditto	Seaward	350	...	....		Ditto	..	Seaward's	...	Morgan's	24	....	
Charon	....	....	....	60	...	3	0	....	..	....	...	Ditto	29	12	0
Centaur	1270	Direct	Boulton and Watt	540	66½	6	0	Tubular	8	Short D	480	Common	18	28	0
Comet	240	Side-lever	Ditto	80	35½	3	6	Flue	4	Long D	40	Ditto	27	14	0
Cherokee	....	Ditto	Mandslay	200	54	5	0	....	..	Ditto	...	Ditto	16	20	0
Columbia	355	Ditto	Boulton and Watt	100	39½	3	6	Flue	4	Ditto	...	Ditto	27	14	0
Cormorant	1056	Direct	Fairbairn	280	65½	5	3	Ditto	6	Ditto	270	Ditto	14	24	4
Cuckoo	....	Side-lever	Boulton and Watt	100	39½	3	6	Tubular	8	Ditto	...	Ditto	27	14	6
Cyclops	1800	Direct	Seaward	320	64	5	6	Flue	5	Seaward's	420	Ditto	16	28	0
Confiance	294	Side-lever	Mandslay	100	40	4	0	....	..	Long D	...	Ditto	23	16	4
Dasher	200	Ditto	Seaward	100	...	3	6	Tubular	..	Seaward's	...	Ditto	25½	15	0
Dover (Iron)	....	Ditto	Fawcett	90	...	3	0	Ditto	..	....	...	Ditto	26	18	6
Dotterel	237	Ditto	....	100	...	3	6	....	..	....	...	Ditto	29	18	8
Dragon	1270	Direct	Fairbairn	560	88	5	9	Tubular	10	Long D	342	Ditto	17	27	6
Dee	800	Side-lever	Mandslay	200	54	5	0	....	..	Ditto	...	Ditto	18	20	0
Devastation	1060	Double cylind'r	Ditto	400	54	6	0	Tubular	5½	Cylindrical	345	Ditto	18	....	
Driver	1060	Direct	Seaward	280	62	5	4	Ditto	8	Seaward's	220	Ditto	19	27	0
Echo	294	Side-lever	Butterly Company	140	44½	4	6	Flue	5	Long D	45	Ditto	18	17	1
Fearless	165	Ditto	Boulton and Watt	70	...	3	0	....	..	Ditto	...	Ditto	32	12	0
Firebrand	1190	Direct	Seaward	400	75½	5	9	Tubular	8	Seaward's	415	Ditto	16	26	6
Firefly	550	Side-lever	Mandslay	220	55½	5	0	Ditto	5	Long D	180	Ditto	21½	20	0
Firequeen (Iron)	312	Steeple	Napier	115	60	3	9	Ditto	10	....	17	Ditto	35	16	6
Flamer	500	Side-lever	Boulton and Watt	120	...	3	6	....	..	Long D	...	Ditto	27	14	0
Fury	1128	Direct	Rigby	515	84	5	9	Tubular	10	Short D	460	Ditto	21½	25	6
Garland	300	Oscillating	Penn	120	43½	4	0	Ditto	16	Locomotive	36	Morgan's	33	19	6
Geyser	1054	Direct	Seaward	280	63	5	3	Ditto	8	Seaward's	300	Common	15	26	6
Gladiator	1190	Ditto	Miller and Ravenhill	430	78	5	9	Ditto	10	....	340	Ditto	22	25	0
Gleaner	....	Side-lever	Boulton and Watt	180	...	3	6	....	..	Long D	...	Ditto	28	18	10
Gorgon	1100	Direct	Seaward	320	64	5	6	Tubular	5	Seaward's	...	Ditto	18	26	0
Grappler (Iron)	587	Double cylind'r	Mandslay	220	..	4	6	Ditto	..	Cylindrical	...	Ditto	..	....	
Growler	1040	Direct	Seaward	290	62	5	8	Ditto	9	Seaward's	290	Ditto	21	26	0

* From "The Marine Steam-Engine," by Main and Brown, 2d Edition, London, 1852.

Name of Ship.	Tonnage.	Kind of Engine.	Maker of Engine.	Nominal Power.	Diameter of Cylinder.	Length of Stroke.	Kind of Boiler.	Boiler Pressure.	Kind of Slide.	Stowage of Coals.	Kind of Wheel.	Revolutions per minute.	Diameter of Wheel.
					in.	ft. in.				tons.			ft. in.
Harpy (Iron)	342	Side-lever	Napier	200	...	4 0	....	..	....	...	Ditto	22½	16 0
Hecate	816	Ditto	Scott and Sinclair	240	60	5 9	Flue	5	Short D	270	Ditto	16	25 0
Hecla	....	Ditto	Ditto	240	...	5 9	....	..	....	...	Ditto	19	24 0
Hermes	830	Double cylind'r	Maudslay	220	40	4 6	....	..	Cylindrical	...	Ditto	19	18 11
Hydra	818	Side-lever	Boulton and Watt	220	...	5 0	....	..	Short D	...	Morgan's	16½	28 10
Inflexible	1124	Direct	Fawcett	378	...	5 9	....	..	....	...	....	..	....
Jackal (Iron)	345	Side-lever	Napier	150	48	4 0	Tubular	8½	Long D	78	Common	21	18 0
Janus	....	Ditto	Made in America	220	...	....	....	..	....	..	Ditto	..	16 6
Jasper	....	Ditto	Fawcett	100	...	3 6	....	..	....	...	Ditto	26	14 8
Kite	300	Ditto	Ditto	170	...	4 8	Tubular	6	Short D	70	Ditto	22	18 0
Lightning	296	Ditto	Maudslay	100	40	4 0	Flue	6	Long D	50	Morgan's	25	17 9
Lizard	....	Ditto	Napier	150	...	4 0	....	..	....	...	Common	22	15 4
Llewellyn (Iron)	650	Direct	Seaward	350	...	....	Tubular	..	Seaward's	...	Morgan's	..	....
Locust	284	Side-lever	Maudslay	100	40	3 6	Flue	5	Long D	64	Common	27	16 0
Lucifer	....	Ditto	....	180	...	4 6	....	..	....	...	Ditto	..	....
Medea	835	Double cylind'r	Maudslay	350	...	...	Tubular	..	Cylindrical	...	....	..	....
Medina	889	Side-lever	Fawcett	312	64	6 0	Ditto	10	Short D	175	Common	19	24 6
Medusa	889	Ditto	Ditto	312	64	6 0	Ditto	10	Ditto	175	Ditto	19	24 6
Merlin	889	Ditto	Ditto	312	64	6 0	Ditto	10	Ditto	175	Ditto	19	24 6
Meteor	290	Ditto	Boulton and Watt	100	39½	3 6	....	..	Long D	...	Ditto	27	14 0
Minos	406	....	....	90	..	....	....	..	....	...	....	..	....
Mohawk	174	....	....	60	...	....	....	..	....	...	....	..	11 6
Monkey	212	Side-lever	Boulton and Watt	80	35½	3 6	....	..	Long D	...	Common	27	14 0
Myrmidon (Iron)	374	Ditto	Napier	150	48	4 0	Tubular	10	....	42	Ditto	24	17 0
Myrtle	116	Ditto	Boulton and Watt	50	...	2 6	....	..	Long D	...	Ditto	34	10 9
Oberon (Iron)	650	Oscillating	Rennie	260	61	5 0	Tubular	10	Locomotive	76	Ditto	21	21 0
Odin	1440	Direct	Fairbairn	560	88½	5 9	Ditto	9	Long D	400	Ditto	18	27 6
Onyx (Iron)	300	Oscillating	Penn	120	43½	4 0	Ditto	16	Locomotive	20	Morgan's	32½	19 6
Otter	237	Side-lever	Boulton and Watt	120	...	3 6	Flue	..	Long D	...	Common	28	14 0
Penelope	1686	Direct	Seaward	650	91½	6 8	Tubular	8	Seaward's	500	Ditto	15½	32 0
Pigmy	...	Side-lever	Fawcett	80	...	3 6	Flue	..	....	...	Ditto	..	....
Pike	....	Ditto	....	50	...	2 6	....	..	....	...	Ditto	35	10 0
Pluto	365	Ditto	Boulton and Watt	100	39½	3 6	....	..	Long D	...	Ditto	27	14 0
Polyphemus	800	Direct	Seaward	200	58	4 6	Flue	4	Seaward's	220	Ditto	17	22 6
Porcupine	380	Side-lever	Maudslay	140	...	4 0	Tubular	..	Long D	...	Ditto	.	15 6
Princess Alice	270	Annular	Ditto	120	...	3 6	Ditto	..	Ditto	...	Morgan's	..	17 0
Prometheus	....	Direct	Seaward	200	...	4 6	....	..	Seaward's	...	Common	..	21 9
Prospero	....	Side-lever	Coates	144	...	4 0	Flue	..	....	...	Ditto	..	14 9
Redwing	139	....	....	60	..	3 6	....	..	....	...	....	..	11 8
Retribution	1641	Double cylind'r	Maudslay	800	72	8 0	Flue, db'le tier	5	Cylindrical	580	Common	14	34 0
Radamanthus	880	Side-lever	Ditto	220	55½	5 0	Flue	5	Long D	...	Ditto	16	20 0
Rocket (Iron)	....	Oscillating	Fairbairn	20	19½	2 0	Ditto	6	Locomotive	3	Ditto	36	10 0
Rosamond	1058	Direct	Miller and Ravenhill	287	...	5 0	Tubular	..	....	...	Ditto	17	28 4
St. Columba (Iron)	600	Side-lever	Forrester	350	...	....	....	..	....	...	....	..	....
Salamander	880	Ditto	Maudslay	220	55½	5 0	Tubular	..	Long D	...	Common	18	21 0
Samson	1297	Direct	Rennie	467	...	5 8	....	..	....	...	Ditto	18	27 6
Scourge	1128	Double cylind'r	Maudslay	420	...	6 0	Tubular	..	Cylindrical	374	Ditto	16	28 0
Shearwater	848	Side-lever	Boulton and Watt	160	...	4 6	....	..	....	...	Ditto	23	17 8
Sidon	1326	Direct	Seaward	560	...	6 4	Tubular	10	Seaward's	650	Ditto	..	27 6
Sphynx	1055	Oscillating	Penn	500	82½	6 0	Ditto	6	Locomotive	380	Ditto	17½	28 0
Spiteful	1050	Side-lever	Scott and Sinclair	280	62	6 0	....	..	Short D	...	Ditto	14	26 0
Spitfire	432	Ditto	Butterly Company	140	44½	4 6	....	..	Long D	...	Ditto	24	17 4
Sprightly	234	Ditto	Boulton and Watt	100	39½	3 6	Flue	..	Ditto	...	Ditto	28	13 4
Stromboli	970	Ditto	Napier	280	63	6 0	Ditto	5	Ditto	255	Ditto	16	25 0
Styx	1050	Direct	Seaward	280	62	5 3	....	..	Seaward's	...	Ditto	16	24 0
Tartarus	800	Side-lever	Miller and Ravenhill	136	...	3 6	....	..	Long D	...	Ditto	28	15 6
Terrible	1800	Double cylind'r	Maudslay	800	72	8 0	Tubular	9	Cylindrical	500	Ditto	14	34 0
Torch (Iron)	450	Side-lever	Seaward	150	...	3 9	Ditto	11	Seaward's	40	Ditto	24	17 0
Trident (Iron)	850	Oscillating	Boulton and Watt	350	...	5 0	Ditto	..	....	...	Ditto	22	22 0
Triton (Iron)	650	....	....	260	..	....	..	..	....	...	Ditto	..	....
Undine (Iron)	284	Oscillating	Miller and Ravenhill	110	...	....	Tubular	..	Locomotive	...	Morgan's	..	....
Urgent	711	Side-lever	Caird	240	62½	5 9	Ditto	8	Short D	100	Common	19½	23 6
Vesuvius	1050	Ditto	Napier	280	...	6 0	....	..	....	...	Ditto	14	25 0
Victoria and Albert	1040	Double cylind'r	Maudslay	430	54½	6 0	Tubular	9	Cylindrical	180	Morgan's	18	31 6
Violet (Iron)	300	Oscillating	Penn	120	43½	4 0	Ditto	16	Locomotive	20	Ditto	32½	19 6
Virago	1040	Direct	Boulton and Watt	300	...	5 0	Ditto	..	Short D	...	Common	17	24 9
Vivid	....	Oscillating	Penn	160	...	....	Ditto	..	Locomotive	...	Morgan's	..	....
Vixen	1040	Direct	Seaward	280	63	5 3	Ditto	8	Seaward's	285	Common	18	26 6
Volcano	700	Side-lever	Ditto	140	...	4 4	Flue	4	Ditto	...	Ditto	21	19 0
Vulture	1190	Direct	Fairbairn	470	..	6 9	Ditto	..	Long D	...	Ditto	20	25 0
Widgeon	225	Side-lever	Seaward	90	...	3 2	....	..	Seaward's	..	Ditto	26	13 9
Wildfire	186	Ditto	Boulton and Watt	75	...	3 0	Flue	..	Long D	..	....	27	13 0
Zephyr	237	Ditto	Ditto	100	39½	3 6	....	..	Ditto	...	Common	28	14 0

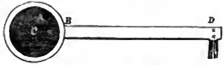
[From d'Aubuisson's Hydraulics.]

Reaction Water Wheels.

We designate by this name, machines in which the water contained in them, and which issues from them with a certain effort, reacts upon the parts of the machine opposite the orifices of issue with an equal effort, in consequence of which it constrains these parts to recoil, and so occasions the motion of rotation. The following example will enable us to appreciate this mode of action; but before giving it, I revert to a principle.

The equality between action and reaction, which is regarded nearly as an axiom in mechanics, has been directly demonstrated by Daniel Bernouilli, in the case of a jet issuing from a vase (*Hydrodynamica*, pp. 279 and 303). He found, by calculation and experiment, that the effort exerted upon the vase by the reaction of the jet was equal to the weight of a prism which had for its base the orifice, and for its height twice the height due the velocity of issue; and we know that such is the measure of the effort of which the jet is capable.

Fig. 1.

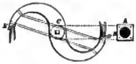


Let there be a vase or great vertical tube, of which A is the base, which is movable around its axis C, at the foot of which is fixed a horizontal tube BD, open at B, and closed through its remaining extent. If this apparatus be filled with water, the fluid will exert an equal pressure on all parts of the tube; that which takes place at any point will be destroyed by the pressure upon the point diametrically opposite, and there will be an equilibrium. But if we make an orifice at *a*, for example, there will no longer be a pressure upon this point: that exerted upon the opposite side will be no longer counterbalanced, and it will drive the tube in the direction from *a* to *c*; the jet issuing at *a*, acting by its *reaction*, will cause the machine to turn around its axis C, and in a direction opposite to its own; in the same manner as the elastic fluid arising from igniting the powder contained in the charge of a squib or rocket, issuing downwards, drives it rapidly upwards.

If, at the lower part of the great vertical tube A, we have radiating from it many tubes similar to BD, and similarly pierced, we shall have the machine of reaction designed, towards the middle of the last century, by Segner, professor of mathematics at Göttingen, which the Germans consequently name *Segner's wheel* (*Segnersche Wasserrad*).

Euler, having made this an object of his studies (*Académie de Berlin*, 1750), proposed: 1st, to give a curved form to the horizontal tubes, so as to obtain a pressure resulting from the centrifugal force; 2d, to cause the water to issue through the extremities of the tubes, which extremities he curved so as to make them perpendicular to the radius of the wheel drawn to them.

Fig. 2.



Lately, M. Manouri d'Ectot, profiting by the indication of these improvements, planned a machine such as shown in the accompanying figure. Its tubes, swelling in the middle, and curved like an ∞, were united and held by iron bars. The motive water is conveyed to them by means of a great vertical tube, which is bent horizontally at D, and, passing under the wings or revolving arms, rises vertically, and terminates at the common centre C.

These wheels have been successfully established in the mills of Brittany, of Normandy, and of the environs of Paris; "from authentic experiments, they produced an effect superior to that of the best executed 'pot-wheels,'" says Carnot, in the name of the commission of the Institute appointed to the examination of this machine (*Journal des Mines*, 1813, tom. xxxiii). I believe, however, that in common practice, we cannot, without difficulty, keep tight the junction of the stationary part, the tube conducting the water, with the movable part, the wings or arms of the wheel. Otherwise, this wheel seems better fitted than any other to transmit the action of a current of water directed from below upwards, such as issues from certain Artesian wells.

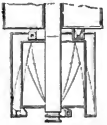
Euler, whose ideas upon these reaction machines were derived from Segner's, designed one which seemed to him better fitted to reap the full advantage of this mode of the action of water. It had the form of a great bell, or rather, it was a truncated cone, hollow in the middle; consisting of two concentric surfaces, made of sheet-iron plates, with a space between them, open at the top and closed at the bottom; small bent pipes were fitted vertically all around, and at the bottom, their extremities being horizontal and in the direction of the motion, or rather, in a direction opposite to it. The motive water entering at the top of the machine, filled the space between the two conical envelopes, and issued through the small tubes. Though unwieldy, this machine has been used advantageously in France.

Three years after, Euler gave a more complete theory of reaction wheels; and on this occasion, he projected a second, which is described in the *Mémoires de l'Académie de Berlin*, 1754. It consisted of two parts, placed one above the other. The upper was immovable, and formed a cylindrical and annular reservoir, with small tubes fixed to the bottom, rectilinear, but inclined at an angle determined by calculation, and delivering the water upon the lower part. The latter, movable around its axis, presented at the top an annular trough, from the bottom of which projected twenty tubes, diverging in their descent, the ends of which, bent horizontally, delivered the water in the air. All of these pipes were covered, as far as the bending, by a smooth sheet-iron surface, designed to lessen the resistance of the air.

Such a machine, with tubes uniformly curved, not being obstructed at their extremity, and not being entirely full of water, has a close resemblance to the duct wheels of M. Burdin, and the theory of Borda would be equally applicable to it.

The learned engineer whom we have just named, and to whom the works of Euler were unknown, also made a *reaction turbine*, which bears a great resemblance to that of the illustrious geometer. We give a short description of one which he established at the mill of Ardes, in the department of *Puy-de-Dôme*.

Fig. 3.



The fall is 6·56 feet. Under a wooden basin, where the water is maintained at a constant height of 3·28 ft., is placed the machine of rotation here represented. Three injecting orifices, fitted to the bottom of the basin, deliver the water horizontally in the crown, or small annular basin, which forms its upper part. It then enters into three pyramidal inclosures, with vertical axes, whose extremities are bent horizontally, having an orifice of issue. The height of the machine is 3·28 ft.; and generally, it is one half the fall.

It is contrived so that the turbine, under the injecting orifices, may have a velocity of 14·53 ft., that due the height of 3·28 ft. The water arriving upon the machine with a velocity equal to that of the points which receive it, there is no shock. Moreover, the head upon the orifices of the conduits being 3·28 ft., the water will issue from them also with the relative velocity of 14·53 ft.; and as that of the orifices in an opposite direction is the same in value, the absolute velocity of the fluid will be zero. The two conditions necessary for the *maximum* of effect are thus fulfilled, and the dynamic effect of the turbine will be PH.

But in practice, many circumstances always occur to change the conditions of this greatest effect. Still, M. Burdin has never seen the useful effect of his reaction turbines below 0·65PH, and sometimes it has been as high as 0.75PH (*Annales des Mines*, tom. iii. 1828).

Nearly a century has elapsed since the theory of reaction machines was the object of Euler's researches; his memoirs upon this subject, which, however, I am not in a situation to properly appreciate, bear, according to competent judges, the impress of his analytical genius. But since their publication, and partly in consequence of the works of this great man, the theory of machines in motion, especially in all pertaining to their dynamic effect, has reached a much greater degree of generality and simplicity.

For a summary application to reaction wheels of this theory, the principal points of which I have already mentioned, I will suppose, with M. Navier, that the water enters them without shock, and runs through them without a sudden change of velocity; I shall only, then, have to consider its absolute velocity immediately after its exit from the machine. We have demonstrated that when water issues through orifices made in the circumference of a wheel in motion around its vertical axis, its velocity, relatively to that of the machine, is, upon the last element of the orifices, $\sqrt{2gh + v^2}$, h being the height of the reservoir above these orifices, and v their velocity of rotation. We suppose their extremity to be horizontal, and perpendicular to the radius of the circumference described; then, their velocity v is found directly opposed to that which the fluid possesses upon this extremity, and its absolute velocity, immediately after quitting it, is then $\sqrt{2gh + v^2} - v$. But the dynamic effect is equal to the force of the motor, minus the half of the *vis viva* which the water possesses after issuing from the machine, and we shall thus have

$$E = Ph - \frac{P}{2g}\left(\sqrt{2gh + v^2} - v\right).$$

This equation shows that the effect is greater, as the complex factor of the second term in the second member is smaller, and that it will be at its *maximum* and equal to P*h*, when this factor is zero; now, we cannot have $\sqrt{2gh+v^2}-v=0$, except v is infinite. Whence we conclude, that in reaction machines, the effect can never be, even in theory, equal to the force of the motor, and that it is greater, in proportion as the velocity of rotation is the more considerable.

Finally, this very year, 1838, M. Combes, mining engineer, took up the theory of reaction machines, and extended it to all the circumstances of motion; after having studied carefully that of Euler, he established a more general one, which he presented to the Academy of Sciences; but as yet, it has not been published. From the short notice upon this subject, inserted in the reports of the sessions of the Academy of Sciences (session of 6th August), the formulæ of M. Combes indicate in reaction machines, what those of M. Poncelet have shown for turbines, that the velocity of the wheel may experience great variations, either increasing or decreasing, from that giving the *maximum* of effect, without a marked diminution in this effect. "It is necessary," observes the author, "that the gates of the reaction wheel should be fixed upon the wheel itself; and in order that the useful effect may remain always the same, notwithstanding the variations in the volume of water, it is requisite that the gates should act at once upon the whole of the orifices of entry and issue of the movable pipes, which should have between them a constant ratio, determined by the equation of motion."

Appendix, containing some observations upon the effect of grist-mills.

The horizontal wheels of which we have been speaking, especially the wheels properly so called, are usually attached to grist-mills; these also present the most frequent examples of vertical wheels; their product is of the most general use, and is most intimately connected with our first necessities; these considerations induce me to state the little that is precisely known as to their useful effect.

What is the resistance opposed by grain to the millstone? this is the first question to be resolved. Its solution will differ for each kind of grain; we restrict ourselves to the most important of all, that of corn or wheat.

Fabre,* from some observations made upon the mills of Provence, estimates the resistance or effort opposed by corn to grinding, supposing that this effort acts at two-thirds of the radius of the runner-stone, as the twenty-second part of the weight of this stone, inclusive of its fixtures.

Calling δ the diameter of the millstone, ϵ its thickness, ϖ the weight of a cubic foot of the material composing it, and ν the number of turns made by it in one minute; its weight is $\frac{\pi}{4}\delta^2\epsilon\varpi$, and its velocity at the extremity of the radius $\frac{\pi\delta\nu}{60}$. The dynamic effect, being the effort of resistance multiplied by the velocity of its point of application, will be

$$\frac{1}{22}\cdot\frac{\pi}{4}\delta^2\epsilon\varpi\times\frac{2}{3}\cdot\frac{\pi\delta\nu}{60}=0{\cdot}00125\delta^3\epsilon\varpi\nu.$$

The specific gravity of siliceous or calcareous stones, of which millstones are made, never varies more than from 150 to 170 lbs. per cub. ft. On account of their fixtures, we raise it to 190 lbs., which will then be the value of ϖ; and we shall have for the expression of the useful effect of the millstone,

$$\cdot 235\delta^3\epsilon\nu^{\text{lbs. ft.}}$$

This value should only be regarded as approximate.

The question of the useful effect of mills may be solved by a method of more direct interest to us, in determining, by experiment, the force necessary to grind a given quantity of corn.

M. Navier, combining and investigating the various published documents upon this subject, concludes that to grind 2·205 lbs. of corn, would require us to impress the millstone with a dynamic force or quantity of action equal to $40202^{\text{lbs. ft.}}$;† there would then be $301520^{\text{lbs. ft.}}$ for a hectolitre or 2·838 bush. of corn, the weight of the hectolitre being 165·4 lbs. as a mean term. We usually estimate the work of a millstone by the number of hectolitres ground in one hour; so that the quantity of action which must be developed during this time will be $3{\cdot}015200^{\text{lbs. ft.}}$ per hectolitre, or $839{\cdot}36^{\text{lbs. ft.}}$ in one second; a force equivalent to that of 1·54 horse-powers. This value is much too small. M. Hachette, measuring the force by means of the dynamometric brake applied to the shaft of the motive wheel of a mill near Paris, which worked only on a large scale, found it 2·26 horse-powers. At the mills in the environs of Toulouse, MM. Tardy and Piobert, with a brake fitted to the shaft carrying the grinding-stone, giving immediately the force of this stone, found it from 2·80 to 2·87 horse-powers. M. Egen, among his numerous dymamometric observations, found it 3·56 at one of the good mills of Westphalia,—mills whose yield is, in truth, very small.

From these facts, and some others, I shall infer, that the force of a millstone, to grind 2·84 bushels of corn per hour, exceeds that of two horses; most frequently, it will be nearer three. To prevent all misreckoning, we will adopt the last estimate; especially if we refer it to the moving wheel of the mill, a wheel which usually transmits its action to the runner-stone through the intervention of gearing, which absorbs a part of this action. We shall consequently admit, *that generally, the force which a mill-wheel should possess is a three horse-power per hectolitre* (2·84 bush.) *of corn ground in an hour.*

As a wheel only takes the m^{th} part of the force of the motive current, the force of this current, on the basis we have laid down, should be $\frac{3}{m}$; the value of m, for the different wheels we may employ, has been given in this chapter. It is about 0·70 for good vertical wheels and turbines; thus, in employing such machines, we should have to count upon a force of water of four horse-powers, at least, for each hectolitre to be ground in an hour. For any wheel, this will be the force of the current, or ·11507QH, divided by $\frac{3}{m}$; or ·03835mQH.

That we may be enabled to judge of the actual amount of work of different mills, and of their mechanical as well as economical effect, I give, in the following table, the results of some authentic observations. I there indicate the kind of wheel used, as well as the value of m corresponding to it, according to the basis above established. In a note concerning each observation, I shall furnish some data in regard to the mill where it was made.

But first, I remark, that the same grinding-stone, with the same discharge of water, and with the same fall, may grind, in the same time, quantities of grain which may vary as one to three, and even more, according as the grain is coarse or fine, hard or soft, or according as it is to be made into the fine flour for the bakeries or the coarse for military stores. So that we must regard only as mean terms the ratios indicated in this table, as well as in the works of different authors, between the quantity of grain ground and the force employed to grind it.

KIND OF WHEEL.		WATER expend'd in 1".	HEIGHT of fall.	GRAIN ground in 1 hr.	FORCE per hect'litre.	m
		cub. ft.	ft.	cub. ft.	horse.	cu. ft.
	(*a*)	31·587	1·000	. . .	3·0	1·00
Bucket-wheels (good)	(*b*)	22·991	3·645	8·75	3·9	0·77
" " (medium)	(*c*)	. . . . .	. . . . .	6·21	7·3	0·41
" " (ordinary)	(*d*)	12·184	5·650	1·67	14.8	0·20
Wheel of trough-mill . . .	(*e*)	7·204	10·105	3·58	8.4	0·35
	(*f*)	8·964	13·287	7·06	6·9	0·43
	(*g*)	8·929	13·128	4·69	10·0	0·30
	(*h*)	10·342	14·304	7·62	8·2	0·36
Wheel of pit-mills.	(*i*)	25·351	7·063	6·89	11·7	0·25
	(*k*)	26·028	7·513	4·41	18·0	0·17
	(*l*)	30·089	7·710	4·41	21·4	0·14

(*a*) "I learn," says Evans (p. 131 of his *Millwright and Miller's Guide*, translated by M. Benoit), "that, from exact experiments, made at the expense of the English government, it is ascertained that a power of forty thousand cubic ft. of water falling one foot, can grind and bolt one bushel of corn." Does the power act directly upon the millstone? If there was an intermediate machine, what was it? Evans does not tell us. The fact which he reports indicates a force of 3·6 horse-powers, for grinding and bolting the hectolitre, equal to 2·84 bushels; I take three for the grinding only.

(*b*) Observations made by M. Mallet, engineer, upon a mill of the English pattern, in the neighborhood of Paris. The grinding-stone was 4·265 ft. in diameter, and made from 100 to 120 turns per minute.

(*c*) General result of very numerous observations of Evans upon the mills of the United States of America. The bucket wheels employed are badly constructed and badly disposed, and present too great a height of water above the summit. The millstones are generally five feet in diameter, and make 100 turns in a minute. (*Miller's Guide*, pp. 118-124.)

(*d*) Egen made this observation upon a mill in Westphalia. The wheel, which was 12·66 ft. in diameter, drove a millstone having only 4.65 ft. in diameter, and making sixty-two turns per minute. It made per hour only 82·22 lbs. of fine flour; the other mills of the country do not yield more, according to the report of the author.

(*e*) This fact relates to a mill established upon a small stream, near Montauban, and working only at intervals; according to the supply of water, it yields 198, 165 and 132 lbs. of flour.

(*f*) I made this observation upon one of the best mills in the neighborhood of Toulouse, the *Bayard Mill*, established on the canal of Languedoc. It was a merchant-mill, and yielded an unusual product; one pair of stones ground 5¾ bushels of corn per hour; and the other, newly sharpened, went as high as 11½ bushels.

(*g*) The ordinary product of the good mills on this canal, which I indicate in this line, is in no case above 220 lbs. of flour, when they work for the bakeries.

(*h*) A mile below the mill of Bayard, is that *des Minimes*, upon which MM. Piobert and Tardy, after having executed the dynamometric experiments mentioned in Sec. 379, also made various observations upon the grinding; that noted in the table was done by a millstone newly picked, and working for traffic; it yielded about six bushels. But at its side was another millstone, which had been picked a month and a half, and which, with a nearly equal force, only made three bushels (of fine flour, it is true); it expended thus per hectolitre a power of more than sixteen horses, though the mechanism was properly disposed.

(*i, k, l*) These three observations were also made by MM. Tardy and Piobert, upon three different stones of the mill of Bazacle. The first had been dressed an hour and a half only, and made flour for ammunition bread. The second had been dressed eight days, and worked for a bakery. Finally, in the last, the flour was ground very fine, and the millstone had been lightly picked some days previous. These grinding-stones, as well as all those of the country, are made of porous silex; they are generally 5·74 ft. in diameter, and make about eighty turns per minute. They do not accomplish, per hour, more than one to one and a half hectolitres, rarely two; and the proprietors of the mills are satisfied if they obtain regularly one hectolitre. Elsewhere, it is said, more is accomplished; and according to M. Taffe, the trough-mills of Provence yield more than six hectolitres per hour, and do not expend a force of six horses per hectolitre.*

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* Essai sur les machines hydrauliques, et en particulier sur les moulins à blé, p. 231.

† Architecture hydraulique, par Belidor et Navier, tome i. p. 464.

* "Application des principes de mécanique aux diverses machines." A current furnishing 14·444 cub. ft. per second, with a fall of 21·65 ft., yields per hour 1056 lbs. of flour; that is 6·40 hectolitres, and a force of 5·02 horse-powers per hectolitre.

[From the London Mechanics' Magazine.]

Lacon's Boat-Lowering Tackle.

AT the twelfth ordinary meeting of the Society of Arts, a paper, by Mr. William Lacon, "On the Management of Ships' Boats, and Loss of Life at Sea," was read by the secretary, in the absence of the author, whose improved mode of lowering boats was therein explained.

In the ordinary mode of lowering a boat, it requires two men in the boat (one at each fall, to unhook), and on board the ship, two men to lower, and two men to clear the falls—no easy matter where the falls are little used, and consequently stiff, and where, as in the case of the largest merchant-steamers, each fall is twenty-two fathoms, or 132 feet long. Under any circumstances, it requires the greatest unanimity of action on the part of these six men; but this is not to be insured during periods of excitement and danger, and during dark nights. If one of the falls should be lowered too quickly, or if one of them should foul, or be accidentally let go, then one end of the boat having reached the water before the other, it is impossible for the men in the boat to unhook at the same time, and an accident must inevitably happen. Or, supposing that all has gone right on board the ship, and that before the boat has reached the water, a sea should lift the stern of the boat and unhook the after-tackle, then, as in the case of the *Amazon*, the boat would sheer across the sea before the people in her could unhook the fore-tackle, and they would thereby be washed out, and the boat would remain hanging by the bow; or if, in the act of lowering, a sea should strike the bow, and unhook the fore-tackle, then the fore-end would immediately fall down, and the people would be precipitated into the sea and drowned.

There is no reason why this operation of lowering a boat should be different from any mechanical operation of the like character. We see, in the every-day operation of raising a weight, that when the weight has attained the requisite elevation, the power is disconnected, and a brake, or other analogous contrivance, is substituted in order to regulate the descent. Why, therefore, should not the same plan be adopted in the case of boats which remain for a lengthened period at the requisite elevation, and which are only required on sudden emergencies? That the principle was acknowledged even by sailors themselves, might be shown in the case of the anchor. After the anchor has been elevated by means of the chain to the level of the water, a tackle, called the "cat," is used to raise it to the level of the deck. This is the power; and sailors know very well, that if they were to allow the same to remain, the anchor could never be used on sudden emergencies; they therefore substitute a single rope (called the "cathead stopper"), and remove the tackle. They remove the one tackle from the anchor; why therefore should they not remove the two tackles from the boats, which, it has been shown, in their use require the greatest unanimity of action?

In Mr. Lacon's method of lowering a boat this is proposed to be effected by a long bar, or rod of iron, with a barrel at either end, of a sufficient size to carry the requisite length of rope or chain, with a friction pulley and brake in the centre. The ropes, or chains, are connected to the barrels in such a manner that they will support any amount of weight till the boat has reached the water, when they will unship, and disconnect by their own weight; by which means he prevents the possibility of the boat being dragged forward, capsized, or swamped, by the motion of the ship. By means of the friction brake he enables one man to regulate the descent of the boat, and by means of the parallel action of the two barrels he insures the boat's descending evenly upon the water.

Diagrams were exhibited, drawn to scale, of the fittings on board two of the Southeastern and Continental Company's ships, with a certificate of experiments conducted at Folkestone, on the 5th of August last, when a boat was lowered several times during the day, while steaming at the rate of twelve and a half knots, with Mr. Lacon and four men in her.

To illustrate the dangers of the present system, several extracts from the evidence of the survivors of the *Amazon* were read, with which most of our readers must be familiar, and other illustrations were taken from the cases of the *Orion* and the *Avenger*, which struck upon the Sorelli on the 20th December, 1847; the *Pegasus*, which struck upon the Goldstone Rock, near the Fern Islands, in July, 1843; the *Solway*, which sank near Corunna, at midnight, on the 7th of April, 1843; the *Conqueror*, wrecked near Boulogne, on the 13th of January, 1842; the memorable destruction of the *Kent*, by fire, in the Bay of Biscay, on the 1st of March, 1825; an incident occurring on board the *Venerable*, 74, on the 20th November, 1804, whilst fishing the anchor; and another, and melancholy one occurring on board the *Melville*, 74, off the Cape of Good Hope, 30th April, 1835. A discussion ensued on the subject of plugs for boats, arising out of the repeated occasions in which, in case of accident, the plugs have been lost, as was the case in the recent wreck of the *Victoria* steamer. Various suggestions were made for securing them, or for the use of a valve which would allow the water to escape from the inside, but would be closed by the pressure of the water underneath. Several contrivances had been patented for the purpose, all of which were to some extent good; but the fact of their being more expensive than the common plugs, kept them from general use. The proper plan was to have the ordinary plugs secured beside the hole, and where that was not done, it was from neglect. A very efficient contrivance had been invented by Captain Claxton, which entirely superseded the plug; it consisted of a small brass tap, fixed in the side of the keel, by which the water escaped from the inside when opened, and when closed entirely prevented the entrance of the sea. Some remarks were also made on the mode of lashing the oars to the boats, and a strap and buckle was suggested to supply the place of cordage, as being more easily undone in the absence of a knife in case of accident.

In answer to a question as to how long Mr. Lacon's plan had been before the public, and whether it had been tried practically,

Mr. Farley stated that it had been before the public about a year, and that it had been tried with great success. Some months ago, the *Queen of the Belgians* steamer made the trial off Folkstone in a high gale of wind. He himself was on board. It was tried first with four men, and the boat was lowered safely whilst the steamer was going at full speed. Again it was tried with two men and Mr. Lacon with equal success, notwithstanding a heavy sea was running high at the time, and the steamer was going at the rate of twelve and a half knots an hour.

A vote of thanks was passed to Mr. Lacon, and the proceedings terminated.

The Nagler Prussian Mail Steam-Packet.

THE Prussian government and the authorities of the Post-office department of that country having decided on accelerating the postal communication through the Prussian kingdom, an order was transmitted to this country for Mr. Elbertzhagen, the agent for the Prussian government in London, to contract for the building of a fast steamer, to be employed in conveying the mails from Stettin to Stockholm, a distance of about 440 miles. In compliance with his instructions, Mr. Elbertzhagen entered into arrangements with Mr. Mare, of Blackwall, for the construction of an iron vessel of 600 tons, to be fitted with oscillating engines of 220 collective horse-power, by John Penn & Son, and the vessel, having been built and fitted with the engines, was tried down the river last week to ascertain her speed. The *Nagler*, the name given to the packet, to commemorate the name of the late Postmaster-general of Prussia, left Penn's wharf, at Deptford, and on arriving at the Lower Hope, in the Sea Reach, below Gravesend, the time was taken, and she ran the measured mile in three minutes thirty-five seconds, or at the rate of 16·744 knots per hour, with the tide. On returning past the measured mile, against the tide, she accomplished the distance in five minutes twelve seconds, or at the rate of 11·538 knots per hour. On again running the measured mile with the tide, she made the distance in three minutes twenty-eight seconds, or at the rate of 17·308 knots per hour; and her last run against the tide occupied five minutes nineteen seconds, or at the rate of 11·285 knots per hour, giving an average speed on the four runs, two down and two up, of 14·320 knots per hour.

Mr. Elbertzhagen, the agent, Captain Graeven, who superintended her construction, Mr. Waterman, jun., who designed the vessel, Mr. Hartree, of the firm of John Penn & Son, the constructors of her engines, and Mr. F. P. Smith, were on board during the trial, and all were much gratified with the result. The *Nagler* is a paddle-wheel steam-vessel, drawing 8 feet 6 inches of water, and her engines, with a stroke of 4 feet 6 inches, made $33\frac{1}{4}$ revolutions on the average of the four runs, the working pressure being 14 lbs. in the square inch. —*London Mechanics' Magazine.*

Carbonic Acid.*

History.—Discovered by Black in 1757, and described by him in his inaugural dissertation on magnesia under the name of *fixed air.* He observed the existence of this gas in common limestone and magnesia, and found that it may be expelled from these substances by the action of heat or acids. He also remarked that the same gas is formed during respiration, fermentation, and combustion. Its composition was first demonstrated synthetically by Lavoisier, who burned carbon in oxygen gas, and obtained carbonic acid as the product. The same experiment has been repeated by Davy, Allen, and Pepys, and others, with the result that in the combustion of diamond or other pure carbonaceous matter the oxygen undergoes no change of volume, or in other words, that carbonic acid gas contains its own volume of oxygen: hence the difference of sp. gravities of carbonic acid and oxygen gases (1·524 – 1·1025), or 0·4215, gives the exact ratio of the quantities of carbon and oxygen combined, being 0·4215 to 1·1025, or 6·12 to 16. Smithson Tennant illustrated its nature analytically by passing the vapor of phosphorus over chalk, or carbonate of lime, heated to redness in a glass tube. The phosphorus took oxygen from the carbonic acid, charcoal in the form of a light black powder was deposited, and the phosphoric acid, which was formed, united with the lime.

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* From Turner's Chemistry, 7th edition, edited by Liebig and Gregory.

Preparation.—Conveniently by the action of hydrochloric acid, diluted with two or three times its weight of water, on fragments of marble, when carbonic acid gas escapes with effervescence, and chloride of calcium is left in solution.

Properties.—Commonly a colorless gas of a pungent odor and acidulous taste, condensable at 32° by a pressure of 36 atmospheres into a liquid, which congeals by the cold produced by its own evaporation, estimated at – 180°, and at that temperature is solid under the atmospheric pressure, being the first instance of a solidified gas. The sp. gr. of the gas is 1·524, and 100 C. I. at 60° and 30 Bar. weigh 47·262 grains; the sp. gr. of the liquid at 32° is 0·83; it dilates remarkably from heat, its expansion being upwards of four times that of air, 20 volumes of the liquid at 32° occupying 29 volumes at 86°, and its sp. gr. varies from 0.9 to 0·6 as the temperature rises from – 4° to + 86°. When heated from 32° to 86° its elasticity rises from 36 to 73 atmospheres, being 0·68 atmospheres for each degree. It is insoluble in water and fat oils, but soluble in all proportions in ether, alcohol, naphtha, oil of turpentine, and bisulphuret of carbon. The evaporation of its ethereal solution causes an intense degree of cold, by which large quantities of mercury may be frozen. (Thilorier in Ann. de Ch. et Ph. lx. 427.)

Its specific heat, in common with that of all the gases, is to some extent uncertain. Crawford's results are admitted to have been erroneous. Several have obtained more accurate results, but those considered most reliable were obtained by Delaroche and Bérard, by observing how far water was heated by the gas during its cooling. Compared with air, volume for volume, the pressure being constant, the specific heats compare as follows:

Air 1·0000, carbonic acid gas 1·2583.

Comparing equal weights, they compare as follows:

Air 1·000, carbonic acid gas 0·828.

Compared with water, equal weights:

Water 1·000, carbonic acid gas ·221.

Carbonic acid gas extinguishes burning substances of all kinds, and the combustion does not cease from the want of oxygen only. It exerts a positive influence in checking combustion, as appears from the fact, that a candle cannot burn in a gaseous mixture composed of four measures of atmospheric air, and one of carbonic acid.

It is not better qualified to support the respiration of animals; for its presence, even in moderate proportion, is soon fatal. An animal cannot live in air which contains sufficient carbonic acid for extinguishing a lighted candle; and hence the practical rule of letting down a burning taper into old wells or pits before any one ventures to descend. If the light is extinguished, the air is certainly impure; and there is generally thought to be no danger, if the candle continues to burn. But some instances have been known of the atmosphere being sufficiently loaded with carbonic acid to produce insensibility, and yet not so impure as to extinguish a burning candle. (Christison on Poisons, 2d ed. 707.) When an attempt is made to inspire pure carbonic acid, violent spasm of the glottis takes place, which prevents the gas from entering the lungs. If it be so much diluted with air as to admit of its passing the glottis, it then acts as a narcotic poison on the system. It is this gas which has so often proved destructive to persons sleeping in a confined room with a pan of burning charcoal.

It is quite incombustible, and cannot be made to unite with an additional portion of oxygen. It is a compound, therefore, in which carbon is in its highest degree of oxidation.

Lime-water becomes turbid when brought into contact with carbonic acid. The lime unites with the gas, forming carbonate of lime, which, from its insolubility in water, at first renders the solution milky, and afterwards forms a white flaky precipitate. Hence lime-water is not only a valuable test of the presence of carbonic acid, but is frequently used to withdraw it altogether from any gaseous mixture that contains it.

Recently boiled water dissolves its own volume of carbonic acid gas at 60° and 30 Bar.; but it will take up much more if the pressure be increased. The quantity of the gas absorbed is in exact ratio with the compressing force; that is, water dissolves twice its volume when the pressure is doubled, and three times its volume when the pressure is trebled. A saturated solution may be made by transmitting a stream of the gas through a vessel of cold water during the space of half an hour, or still better by the use of a Woulfe's bottle or Nooth's apparatus, so as to aid the absorption by pressure. Water and other liquids which have been charged with carbonic acid under great pressure, lose the greater part of the gas when the pressure is removed. The effervescence which takes place on opening a bottle of ginger beer, cider, or brisk champagne, is owing to the escape of carbonic acid gas. Water, if fully saturated with carbonic acid gas, sparkles when it is poured from one vessel into another. The solution has an agreeably acidulous taste, and gives to litmus paper a red stain which is lost on exposure to the air. On the addition of lime-water to it, a cloudiness is produced, which at first disappears, because the carbonate of lime is soluble in excess of carbonic acid; but a permanent precipitate ensues when the free acid is neutralized by an additional quantity of lime-water. The water which contains carbonic acid in solution is wholly deprived of the gas by boiling. Removal of pressure from its surface by means of the air-pump has a similar effect.

The agreeable pungency of beer, porter, and ale, is in a great measure owing to the presence of carbonic acid: by the loss of which, on exposure to the air, they become stale. All kinds of spring and well water contain carbonic acid absorbed from the atmosphere, and to which they are partly indebted for their pleasant flavor. Boiled water has an insipid taste from the absence of carbonic acid.

Carbonic acid is always present in the atmosphere, even at the summit of the highest mountains, or at a distance of several thousand feet above the ground. Its presence may be demonstrated by exposing lime-water in an open vessel to the air, when its surface will soon be covered with a pellicle, which is carbonate of lime. The origin of the carbonic acid is obvious. Besides being formed abundantly by the combustion of all substances which contain carbon, the respiration of animals is a fruitful source of it, as may be proved by breathing for a few minutes into lime-water; and it is also generated in all the spontaneous changes to which dead animal and vegetable matters are subject. The carbonic acid proceeding from such sources is commonly diffused equably through the air; but when any of these processes occur in low confined situations, as at the bottom of old wells, the gas is then apt to accumulate there, and form an atmosphere called *choke-damp*, which is fatal to any animals that are placed in it. The accumulations happily never take place, except when there is some local origin for the carbonic acid; as, for example, when it is generated by fermentative processes going on at the surface of the ground, or when it issues directly from the earth, as happens at the Grotto del Cane in Italy, and at Pyrmont in Westphalia. There is no real foundation for the opinion that carbonic acid can separate itself from the great mass of the atmosphere, and accumulate in a low situation merely by the force of gravity. Such a supposition is contrary to the well-known tendency of gases to diffuse themselves equally through each other. It is also contradicted by observation; for many deep pits, which are free from putrefying organic remains, though otherwise favorably situated for such accumulations, contain pure atmospheric air.

Though carbonic acid is the product of many natural operations, chemists have not hitherto noticed any increase in the quantity contained in the atmosphere. The only known process which tends to prevent increase in its proportion, is that of vegetation. Growing plants purify the air by withdrawing carbonic acid, and yielding an equal volume of pure oxygen in return; but whether a full compensation is produced by this cause has not yet been satisfactorily determined.

Carbonic acid is contained in the earth. Many mineral springs, such as those of Tunbridge, Pyrmont, and Carlsbad, are highly charged with it. In combination with lime it forms extensive masses of rock, which geologists have found to occur in all countries, and in every formation.

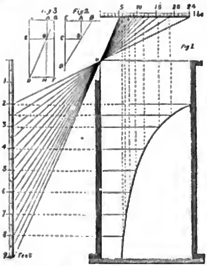
Carbonic acid unites with alkaline substances, and the salts so constituted are called *carbonates*. Its acid properties are feeble, so that it is unable to neutralize completely the alkaline properties of potassa, soda, and lithia. For the same reason, all the carbonates, without exception, are decomposed by the hydrochloric and all the stronger acids; when carbonic acid is displaced, and escapes in the form of gas.

Its eq. is 22·12; eq. vol. = 100; symb. $C + 2O$, CO_2, or $\ddot{C}$.

Pressure of Steam working Expansively.

The following geometrical method of finding the pressure of steam at any point of the stroke of a steam-engine working expansively, according to Marriott's law, we find in a late number of the London Artisan. It is credited to Mr. J. S. Holland, of the Steam Branch, Admiralty, Somerset House.

Draw a cylinder, as in Fig. 1, and let the diameter be drawn to any convenient scale representing the full pressure; let such scale be placed parallel and even with the top of the cylinder, at the distance from it equal to the cut-off measured on the scale of feet representing the stroke, which last scale must be placed parallel and even with the side of the cylinder, and at the distance, from the near inner edge, of the diameter of the cylinder. To find the pressure of steam at any point of the stroke, draw a line from the scale of feet representing that point through the point o at the top of the cylinder, continued to the scale of pounds, and on that scale we have the corresponding pressure. If we now draw perpendiculars from these two points, they will intersect in a point in the hyperbolic curve representing the varying pressure.



Demonstration.—If in Fig. 2 we draw a line through the point *o*, so as to cut the lines A B and C D, the rectangle A B C D will be a constant quantity, and equal to the rectangle E *o*. This will at once be seen, on reference to Fig. 3, which is that of Euclid, b. 1, prop. 43, where it is shown that the rectangle E O is always equal to the rectangle O F. Now the scale of pounds represents the line A B, and the scale of feet represents the line C D.

Fig. 1 represents a cylinder with steam of 24 lbs. cut off at 2 feet. The pressure at 4 times 2 feet will be ¼ of 24, or 6 lbs. On looking at the figure, we find that a line drawn from 8 feet through the point o, gives 6 lbs. on the scale; and a vertical line from 6, to cut a horizontal line drawn from 8, gives a point in the curve. The scale of feet is placed from the near side of the cylinder, at the distance 24 measured on the scale of pounds, and the pounds scale is placed feet above the top of the cylinder, as measured by the scale of feet.

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Engines of the Vaguero.

(See Plate 6.)

The Vaguero, which sailed from this port for Cuba on the 21st ult., may be considered, in every respect, one of the best specimens of a modern auxiliary propeller. The hull was modelled and built by George Steers, Esq., the designer of several of our finest specimens of naval architecture, among which may be included the world-renowned yacht America. The engines were designed and constructed by Messrs. T. H. & E. Faron, of the Faron Iron Works, East River. The vessel is 145 feet keel, 155 feet on deck, 24 feet 4 inches breadth of beam moulded, and 10 feet depth of hold. She draws, with 175 tons of coal and stores on board, 8 feet of water. The engines are remarkable only for the extremely small space occupied, and novel method of obtaining the valve movement. The cylinders, as will be observed by referring to the plate, are oscillating, with slide-valves and the usual cut-off, and inclined to an angle of 36° when on their centres. They are 26 inches diameter, 28 inches stroke, and geered, by the internal geer represented, in the proportion of 2¾ to 1. The view given in the plate is a front elevation, the stout timber-frame being removed on one side to allow a fair section of the cylinder port, behind which appears the after and similar frame. Both frames, and a portion of the dead wood, as also a portion of the flange on the large geer-wheel, is represented as broken through at a lower point, to allow a view of the pinion and shaft of the propeller.

The valve motion is derived principally from the oscillation of the cylinders, the connection being to cranks of about 2 inches throw on the shaft of the hand-wheel in the centre. The latter shaft is in line with the main shaft, and is carried round with it by means of arms and adjusting screws, which meet the extremity of the crank-pin, extended for the purpose. There are two arms on the shaft, making with each other an angle of about 140°, the extra arm coming into play on reversing the engines.

It will be observed, by examining the section, that the valve receives its motion immediately from a geered segment on a shaft traversing the valve-chest. The full elevation shows the arms on the end of this shaft, which arms are in fact one piece, with a curved slot, for the convenient transfer of the connection from one arm to the other. This transfer is effected by means of a small geer-wheel taking into a rack fixed near the side of the slot. The connecting-pin, and consequently the small geer-wheel, is turned by a small hand-wheel on its extremity. This wheel is omitted in the plate. In facility for reversing, it will be seen that this method is inferior to the more complicated arrangements usually employed.

Behind the port cylinder is dotted the pump-shaft and arm, worked by connection with a crank on the after end of the driving-shaft. From arms on this shaft are worked the air and feed pumps, which are placed horizontally on the starboard side, and secured to the condenser. The condenser and hot well are cast in one piece, the capacity of the former being 20 and the latter 8 cubic feet. The air-pump is 23 inches diameter, and 18 inches stroke, with solid piston. The feed-pump is 4½ inches diameter and 14 inches stroke. The valves of the air-pump are of india-rubber, and of the usual construction. The boiler is a single ascending return-flue, 21½ feet long; diameter of shell, 8 feet; width across the front, 9 feet. Two furnaces present each 20 square feet of grate surface; and the whole heating surface of the boiler is 1000 square feet. The consumption of anthracite is estimated at about five tons per day; number of revolutions under steam alone, from 30 to 35; pressure of steam, about 25 lbs., cutting off at half stroke.

The propeller is of brass, 3 bladed, 8 feet in diameter, 16 inches long, and weighs 2100 lbs. The pitch is 10 feet, expanding to 11. Working-surface, exclusive of hub, 24 square feet. The diameter of the propeller-shaft is 6½ inches—the thrust of the propeller being taken by 6 collars, working in a corresponding box of brass.

The rig is that of a three-masted schooner, with square-sail on the foremast. She spreads 1500 square yards of canvas.

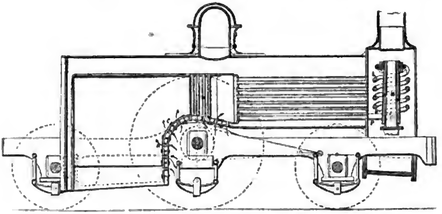
The Vaguero is owned by an Havana company, and is designed especially for freighting between that place and the southern ports on the island. A two-way cock is provided for the extinguishment of fires, by turning which a volume of steam from the boiler may be turned into either the coal-bunkers or the hold. On the starboard side of the engine-room, which is also the fire-room, is a vertical steam-engine, 8 inches diameter, 12 inches stroke, working a double-acting force-pump for extra feed, and an apparatus for hoisting goods or coal. The fire-annihilator, *i. e.* the steam-cock alluded to, is worked from the deck, and cannot be too highly recommended. A similar simple arrangement (worked occasionally to insure its perfect order) would be the means of avoiding many disastrous calamities on our passenger boats. The workmanship of this vessel is all of the most substantial kind, and reflects much credit on the thoroughly American design and construction.

Powerful Express Locomotive and the Principles involved in its Operation.

An experimental train of 35 cars, loaded with 5 tons each, was recently drawn by one locomotive from Birmingham to London in three hours. This was over a road, much of which was in what our English friends consider "bad condition." The performance, which is pronounced by the *London Mechanics' Magazine* the most extraordinary ever yet accomplished, was by one of McConnell's Patent Locomotives, the peculiarities of which are quite fully detailed by the specification copied in the February number of our present volume, page 30. The distance is 112 miles, a journey which these engines are expected soon to make with heavy trains, in two hours.

The accompanying sketch illustrates several of the principal features of these locomotives.

The fire-box is extended in length into the body of the boiler, giving more direct heating and less tube surface than the usual forms. The lower side of the boiler is indented transversely, forming a recess for the axle or cranks, and allowing the centre of gravity of the boiler to be lowered, an object of considerable importance with large drivers. An apparatus for heating the feed water in its passage from the pump to the boiler, is represented by the coiled pipe and the annular space surrounding the blast-pipe. The water is forced through the coils E, absorbing heat from the products of combustion by which it is surrounded, into the annular space OM, in which it also absorbs a portion of the heat from the steam in the blast-pipe N, and finally enters the boiler through the pipe P. This heating may be carried to any desired extent by simply increasing the length and number of coils in the feed-pipe, the practical limit being imposed by the necessity of allowing a tolerably clear passage for the draught. The flat steam-pipe with tubular stays, for more effectually drying the steam in its passage through the smoke-box, has been before described.



Perhaps the most valuable improvement introduced in these locomotives, is the combination of any required amount of fresh air with the products of combustion in the fire-box by means of the tubular stays A, which may be covered by caps or valves at the pleasure of the engineer. Carbon combines with oxygen in two proportions, and the loss by the formation of carbonic oxide instead of carbonic acid, in the furnaces of steam-boilers, has long been felt, and only tolerated as a necessary evil attendant on rapid firing. The amount of loss from this source is difficult to estimate, but is supposed to be considerable. The blue flame sometimes observed about the tops of the chimneys of steamers is due to the combustion of small quantities of carbonic oxide, and the smoke-box of a locomotive has sometimes been maintained at a red heat by the combustion of this gas in consequence of atmospheric air being supplied through leaks. The *rationale* is something as follows. When air is supplied to a furnace in sufficient quantities, the carbon or fuel which is undergoing a rapid decomposition, termed combustion, absorbs from the air a sufficient quantity of its oxygen to form carbonic acid gas. One atom of carbon unites with itself two atoms of oxygen, the useful effect being the production of a certain amount of heat. If however the heat be intense and the supply of oxygen limited, a portion of the fuel burned becomes carbonic acid, while another, and under some circumstances a greater portion, combines with but half its due quantity of oxygen, one atom of each, in which process it yields but a portion of the heat due to a perfect combustion, and remains in a condition ready to yield the remainder if supplied with fresh air in a sufficiently heated state. This has been before attempted by leaving small holes in the doors or other portions of the furnace. Assuming, as is supposed by some experimenters, that the heat of combustion of any fuel is always proportional to the oxygen absorbed, it is easy to see that the loss by the escape of the oxide instead of acid is 50 per cent. of the whole effect of the fuel. Others have computed the loss to be as high as 70 per cent., though the highest economy yet obtained in practice by complete combustion of this gas is we think but a trifle above 12 per cent. The forward end of the fire-box in this construction is termed a combustion chamber, serving as a space for the reception and thorough mixture of the air which is admitted through the hollow stays as represented by the arrows. The quantity of air required for the combustion of pure carbonic oxide is variously estimated. From the consideration of its atomic constitution presented above, it would require an additional amount equal to that employed in its manufacture. According to Berthollet, "carbonic acid is formed by burning a mixture of 50 volumes of oxygen and 100 volumes of carbonic oxide." When it is considered that oxygen forms only about 20 per cent. of the volume of atmospheric air, it would appear that for the perfect combustion of two cubic feet of carbonic oxide, five cubic feet of air are required. This appears inconsistent with the supposition of a smoke-box becoming red-hot in consequence of the admission of air through accidental cracks, a fact which, though not within our own observation, is supported by the best authority.

A notice of these engines in an English mechanical work, apparently written or authorized by Mr. McC., assumes that the gas requires to be mixed with only about one-fifth of its bulk of atmospheric air to produce perfect combustion, being without this incombustible, but whether this quantity was obtained by experiment or otherwise, is not mentioned.

An undue prominence may have been given to the designer of this particular style of engines, Mr. J. E. McConnell, of Wolverton, in connection with this subject of thorough combustion, he being by no means the first to seek the same end by precisely similar means. A great partiality however for practical results, is a very justifiable weakness in treating mechanical questions, and all familiar in any degree with the subject, will concur with the Magazine quoted at the commencement, in admitting that the performance in this single instance on Tuesday, March 8th, is deserving of permanent record.

LIST OF PATENTS,

Issued from the U. S. Patent Office during the month of April, 1853.

J. H. Bloodgood, of Rahway, N. J., for Forming Yarn by Felting.

Claim.—I claim the formation of thread or yarn from woollen rovings, by the process of felting, instead of twisting or spinning, substantially as set forth.

T. D. Burrall, of Geneva, N. Y., for improvement in Grain Harvesters.

Claim.—I claim, first, the additional apron, to convert the usual rear-discharge into a side-discharge of the cut grain, constructed and arranged as set forth.

Second, the combination of the curved supports and the adjustable journal-box piece, to preserve the relative positions of the cogs in the mitre-geering, and at the same time allow of raising and depressing the driving-wheel, the geering, &c., being constructed and arranged as described.

Solomon Horney, Jr., of Richmond, Ind., for improvement in Ploughs.

Claim.—I claim constructing the shank hollow in a single piece, with two closed ends, as described, and securing the same to and with the share and beam, by means of the master-bolts, and the short bolt for passing through the slot in the top end of the hollow shank, for varying the position of the shank with the beam, and for giving additional security to the fastening of the same, as set forth.

Wm. H. Lindsay, of New York, N. Y., for improvement in Water Meters.

Claim.—I do not claim operating the valves of the main engine or cylinders by means of a secondary or independent engine, the valves of which are actuated through the medium of the primary engine, the same being well known in the construction and operation of hydraulic engines, &c.

But what I claim is, first, operating, as described, the valves of a secondary engine by the main engine, through a portion of their movement, and completing the same through the medium of the secondary engine.

Second, connecting the cross-head of the main cylinder with its valves, in the manner described, so that said valves will close the ports of the main cylinder, in case the working parts of the secondary engine should fail to do their duty.

Third, I do not claim the balancing of slide-valves, as such has heretofore been done in various ways; but I claim forming a recess or recesses in the under or working side of the slide-valve, in combination with the secondary opening or openings through the seat, or in the side of the port or ports, for the purpose and in the manner substantially as described.

Fourth, I do not claim making a connection between opposite sides of the plunger-piston at a certain portion of its travel, as that has heretofore been done; but I claim the combination of the bridge in the cylinder, in combination with the openings in the plunger, for the purpose as described.

Thompson Newbury, of Taunton, Mass., for improvement in Feeding Blanks to Screw Machines.

Claim.—I claim the slide, substantially as described, passing up through the bottom of the hopper, in the manner set forth.

Henry R. Nott, of Lewisburgh, Pa., for improvement in Sash Fasteners.

Claim.—I claim, first, arranging the spring-catch fastenings for the upper and lower sash, about the middle of the frame, in such manner that the upper sash can be managed, or fastened and unfastened, without interference from the lower sash, as set forth.

Second, the particular arrangement of the attachments on the one plate of the two spring-fastenings; said arrangement consisting in the swing-bar (through which the spring-bolt of the upper sash is operated), with its hinge-joint in the rear of the spring-bolt and the bar, and the bolt of the lower sash, by which I gain economy of room and a cheap and efficient action upon the two sashes, in the manner set forth.

Charles J. Pownall, of Addison Road, England, for improved Mode of Preparing Vegetable Fibre. Patented in England, for Ireland, Aug. 11, 1852.

Claim.—I claim the mode of subjecting fibrous vegetable substances to repeated mechanical pressure, and the action of a stream of water, for the purpose of depriving them of resinous or gummy matters, and also resolving them into their ultimate or finer fibre, as described.

Samuel Rust, of New York, N. Y., for improvement in Sector Presses.

Claim.—I claim, first, one or more bearing-pieces at the sides or in front of the eccentric sector, acting upon any fixed point or rest on the press-frame, for the purpose of raising or withdrawing the punch or pressing appendage, by power applied to the sector, in the reverse direction to that by which the pressure is given, as specified.

Second, allowing to the eccentric sector a sufficient amount of motion directly in the line of the pressure, to enable it to follow, and always to keep in contact, and in proper relation to the eccentric sector, as set forth.

Elliot Sawyer, of Berlin, Ct., for improvement in Cutting the Threads of Wood-Screws.

Claim.—I do not claim the combination of mechanism for holding and rotating a screw blank, and mechanism for carrying a cutter or chisel against the blank, and regulating the movements of that cutter by a screw; but I claim the endless elongated chaser as constructed and made to turn and move on a pin, or its equivalent, and to act against a screw-blank while in rotation and movement, as specified.

And in combination with the elongated endless chasers, and the screw-blank holder, I claim the feeding-cam or apparatus as applied, so as to be operated by the chaser, and to feed it forwards against the screw-blank, as specified.

And, in combination with the elongated endless chaser and its sustaining carriage, I claim the movable rail and groove, together with mechanism for elevating and depressing the rail, as stated; the mechanism, as described for such purpose, being the two grooves and their inclined planes, and the studs and the springs of the rails.

And in combination with the elongated endless chaser and its operating screw, and elongated endless worm-geer, and the feeding apparatus of the chaser, I claim mechanism for withdrawing the driver from the head of the screw, or releasing the screw from the machinery by which it is put in rotation, mechanism for removing the cut screw from the endless chaser and presenting another screw-blank to the operation of it, as described, and mechanism for restoring the driver and other parts to their correct positions, to again set in motion the screw-cutting machinery; the machinery as described for actuating the driver being the cam, pitman, rocker-shaft, bent arm, and forked lever; that for removing the cut screw from the chaser, and presenting to it a fresh screw-blank, being the rotary blank-holder, geer-wheel, and arms; that for restoring the driver and other parts to their correct positions, to again set in motion the screw-cutting machinery, being the pitman and the spring, the whole being applied and made to operate together, as specified.

William Smith, of New York, N. Y., for improvement in Weaving Corded Fabrics.

Claim.—I do not claim two shuttles, as two or more have been used in various kinds of weaving; but I claim the process of forming a fabric by the combination of stationary movable warps, with two weft threads passed simultaneously through the two sheds formed above and below said stationary warps by the movable warps.

William M. Storm, of New York, N. Y., for plan for Mixing Air and Steam for Actuating Engines.

Claim.—I claim generating the steam for intermixture with the air, or other gaseous body, in direct contact with the latter; the same (the air or gas), not being the hot product of combustion, nor to arrive at the place of admixture from direct contact with any body of fuel undergoing combustion, for the reasons stated.

I also claim the plan of generating the steam for such purpose in some comparatively dry vessel or heater, for the reason given, the water from which such steam is so generated being mainly held, while vaporizing, in suspension in the air, for the objects specified; the air and water to that end being caused, by some adequate means, to meet with an extensive surface of mutual contact, as explained.

Gregor Frinks, of Jersey City, N. J., for improvement in Brakes for Railroad Cars.

Claim.—I claim so combining the shoe-frame with the ordinary truck or car, as that it may be raised and lowered by the operation of the brake-lever, so as to be carried by the truck or to receive the weight of the car, to aid in applying the brakes, and so that the wheels shall not come in contact with the shoes, but be free to turn, as described.

Also giving the truck or car a motion independent of the shoe or brake-frame, by means of the curved inclined planes or their equivalents, on the shoe-frame, up which the axles of the trucks may roll by an easy swinging motion, whilst its entire weight continues to aid in applying the shoe or brake to the surface of the rails, as described.

J. J. Updegraff, of Selin's Grove, Pa., for improvement in Stoves.

Claim.—I claim, first, the combination of the central hot-air passage, the annular fire-chamber, and tubular fire-pot, for the full economy of heat, as set forth.

Second, the combination of the outer casing, tubular fire-pot, and central hot-air passage, as described, so that the currents from each may all unite and co-operate, as set forth.

William Berlin of Berryville, Va., for improvement in Harrows.

Claim.—I claim constructing a double frame-work of iron bars or straps of metal, and arranging and combining the two together by graduating bolts or adjustable screws and taps, by which means or contrivance the lower frame can be elevated or depressed, and the teeth or tines lengthened or shortened in their drag or dip.

Edwin L. Bushnell, of Poughkeepsie, N. Y., for improvement in Spring Mattresses.

Claim.—I claim the mode or principle of securing the springs, by attaching the free extremity of each spring to the terminal coil of the adjacent spring, so that they mutually support each other, without the use of any inflexible frame of wood or other material, at the same time that in rolling or folding up the mattress, the outside ends of the springs are exposed or open while the inside ends contract or close, and by which means any article so constructed will admit of being rolled or folded upon itself, or compressed, substantially as described.

H. L. Fulton, of Chicago, Ill., for improvement in Smut Machines.

Claim.—I am aware that a flat plate on the side of the concave has been used; this, therefore, I do not claim; but I claim the circular prismatic-shaped brace and concentrator, arranged between each pair of revolving scouring-plates, and secured fast to the inner periphery of the case, for the purpose of concentrating the grain and throwing it upon the second scouring-plate, and thereby preventing its escape, before it is effectually cleaned from the first scouring-plate, directly to the discharge passage, as described.

Also, in combination with the revolving dish-shaped plates, or beaters, substantially as described, the prismatic ring, for the purpose of concentrating and directing the grain from one beater to the other, as described.

Reuben F. Gustine, of Chicago, Ill., for improvement in Match Splint Machines.

Claim.—I claim the combination of the reciprocating knife with a convex or protuberant rest, and feeding and holding mechanism, and the pressure-roller, or any equivalent thereof, for the purpose described.

J. J. Hatcher, of the district of Spring Garden, Pa., for Coin Safe and Detector.

Claim.—I claim a coin safe, or receptacle for coin, consisting of the arrangement of the outer case, spring, with a pad, for holding the coin up against the top of the case, and slide with its projection, or their equivalents, for forcing out the coin through the slot provided for the purpose, as described.

S. W. Hawes, of Boston, Mass., for improvement in the Manufacture of Rosin Oil.

Claim.—I do not claim the form or kind of apparatus set forth, irrespective of its use or particular application; my claims being founded upon the invention or discovery of improvements in the process of making rosin oil by means of said apparatus, or any other equivalent in principle.

Therefore I claim, first, in the process of making rosin oil, charging and discharging the still by means substantially the same in principle or mode of operation as there set forth, whereby I save the necessity of unluting, and prevent the incrustation of the still.

Second, I claim in the process of making rosin oil the separation of the oil from the more volatile products at different and distinct points remote from the still, instead of discharging them altogether, as heretofore done, as set forth, by means of the series of recurved pipes in combination with the series of condensers attached thereto, as set forth.

Simon Ingersoll, of New York, N. Y., for improvement in Shingle Machines.

Claim.—I claim the spring clipper, operated as described, in combination with the riving-knife, for the purpose of insuring the complete separation of the shingle from the block, and, at the same time, throwing it on the lower bed, in position to be carried to the dressing-knives by the next advance of the driver, as set forth.

E. A. Tuttle, of Williamsburgh, N. Y., for improvement in Hot-Air Registers.

Claim.—I claim constructing the leaves of a register or ventilator with projections on their surfaces, to form an ornamental open or fret work between the leaves, when they are turned with their edges uppermost or partially so, for the purpose of dispensing with the separate front or top plate of ornamental open-work now employed on registers and ventilators.

William H. Johnson, of Granville, Mass., for improvement in Sewing Machines.

Claim.—I claim the use of a hollow rotary clamp, as described, for holding and feeding cloth or other materials to be sewed, substantially as specified.

B. F. Upton, of Bath, Me., for improvement in Mercury Baths for Daguerreotyping.

Claim.—I claim combining with the mercury bath and the lamp for heating it, the sliding tube and lever, or their mechanical equivalents, as described, so that by the expansion of the bath the lever may be moved so as to elevate the slide-tube on the wick, and thereby decrease the flame of the lamp and the heat thereof, or caused so to act as to maintain, or nearly so, equality of evaporation, as specified.

C. F. Wilgus, of West Troy, N. Y., for improvement in Washing Machines.

Claim.—I claim the employment of the revolving feeding net-cylinder, in combination with the two sets or circles of rollers, one set of said rollers being allowed to yield when the sack of clothes or other articles is drawn round the net-cylinder, and between the said sets of rollers, and made to spring back by means of the springs which are connected to the rollers, the whole being constructed, arranged, and operated as described, and for the purpose of washing clothes and fulling and flocking cloths, as set forth.

Charles Goodyear and Robert Haering, of New Haven, Ct., (assignors to Charles Goodyear), for improvement in Manufacturing India-Rubber and Gutta Percha. Patented in England, March 4, 1851.

Claim.—We claim the art or method of manufacturing articles composed in part of caoutchouc, or other gums susceptible of vulcanization, by heating or vulcanizing the same when surrounded with or pressed upon externally or internally by, or moulded in, pulverized soapstone, sand, plaster, or other similar granular, pulverized, or porous matter, or in moulds of plaster or other porous substance, as described.

Cullen Whipple (assignor to the New England Screw Company), of Providence, R. I., for improvement in Shaving the Heads of Screw Blanks. Patented in England, November 30, 1852.

Claim.—I am aware that in machines for shaving the heads of screw blanks, the shaving-cutter, whether moving on a slide or a rocker, has been moved towards and from the blank obliquely to the axis of the blank, and therefore I do not claim, broadly, the moving of such cutter obliquely: but I claim the method of shaving the heads of screw blanks, by causing the cutter to approach the blank obliquely, and in line, or nearly so, with the under side of the head, whereby the use of a rest to support the blank against the pressure of the cutter is dispensed with, as set forth.

F. A. Calvert, of Lowell, Lass., for improvement in Willowers.

Claim.—I claim the combination of a set of feeding rollers and endless feeding apron, having an intermittent motion imparted to them, for the purpose set forth, with the cleaning cylinder of a willower.

J. M. Cook, of Taunton, Mass., for excluding Dust from Railroad Cars.

Claim.—I lay no claim to the application of vertical blinds, shutters, or screens, on the outside of railroad cars, and made to stand at angles of about forty-five degrees therewith, for the purpose of preventing the entrance of dust, smoke, or cinders into the windows thereof.

But I claim the manner of constructing and applying a deflector to the outside of a railroad car, the same consisting not only in making it to extend along the bottom horizontal or lower part, but up along the vertical side of a window opening, the air impinged against by the vertical face of the guard, will be driven or moved downwards, and made to pass under or over the guard, so as to prevent the dust thrown directly upwards from the track, as well as that moving horizontally, or otherwise, from entering the windows, as described.

Phineas Emmons, of New York City, for Planking Hat Bodies.

Claim.—I claim the combination of a reciprocating rotary rubber or presser, with an endless elastic apron, so that by vibrating said rubber, a reciprocating intermittent differential movement is given to the apron, thereby operating on both sides of the body and working it forward at the same time, substantially in the mode of construction and manner of operation, as set forth.

J. A. Hartupee & Abram Alexander, of Pittsburgh, Pa., for Rolling Bar-Iron.

Claim.—We claim the combination and arrangement of the two parallel horizontal rollers, with the two vertical rollers, in such a manner that by raising or lowering the upper roller, to form a thicker or thinner bar, one of the vertical rollers will be raised or lowered with it, and at the same time, the peripheries of all the rollers, be kept in contact and in their proper relative position with each other, and also in such a manner that by moving the lower horizontal roller endwise in its bearings, to make a narrower or a broader bar, the aforesaid vertical roller will be moved laterally with the said lower horizontal roller, while at the same time the peripherias of all the rollers will be kept in contact, and in proper relative positions with each other, as set forth.

Alex. McPherson, of New York City, for Cooking Ranges.

Claim.—I claim the arrangement of the vertical end flues, and diagonal cross plate under the oven, for causing the gas to traverse under the entire surface of the oven of the cooking range, operating as set forth.

John H. Manny, of Waddam's Grove, Ill., for improvement in Harvesters. Patented in England Dec. 9, 1852.

Claim.—I claim constructing the lower part of the finger or the upper, or both, with a recess on either side in front of the finger bar, and an angular ridge between the two recesses, to cut entangled fibres, whereby the clogging of the cutting apparatus is effectually prevented, as described.

Also constructing the fingers so that the sides of its upper half will overhang those of its lower half, the cutter playing between the two, substantially as set forth.

Samuel Miller, of Washington College, Tenn., for improvement in Cotton Seed Planters.

Claim.—I claim the combination of the open or latticed bottom of the seed hopper, with the teeth on the axle passing through them into said hopper, for the purpose of drawing or forcing out the seed, so that they may be drilled into the ground, the whole being arranged in the manner set forth.

T. Nowbury, Taunton, Mass., for improvement in making Screw Blanks.

Claim.—I claim the detached tool posts, arranged as described, in combination with the comb-arm and arm for carrying the threading tool under an arrangement and construction, as set forth.

Amasa Woolson, of Springfield, Vt., for improvement in Gig Mills for Dressing Cloth.

Claim.—I claim in a gig mill, or other machine for dressing cloth, hanging the cloth rollers in a revolving carriage, or its equivalent, by means of which the cloth is run in a reversed direction through the machine without the necessity of unwinding it from and rewinding it upon the cloth rollers, as before practised.

William Wickersham, of Lowell, Mass., for improvement in Sewing Machine.

Claim.—I lay no claim to the combination of a single hooked needle and two thread guides or carriers, as made to operate together in a knitting machine, and for the purpose of laying two threads over the needle, during the process of the formation of a knit fabric; but I claim the combination of a single needle and two thread guides, carrying separate threads, so operating, that during one passage of the needle through and out of the cloth, or other material to be sewed, one of the said guides shall lay its threads into the hook of the needle, while during the next passage of the needle through and out of the cloth, the other guide shall lay its thread in the hook of the needle, each guide acting, alternately, as specified.

And for the purpose of enabling a machine of the above description, or one in which two thread guides and a single needle are employed to sew with two threads, to be used for producing the chain stitch, with one single thread, passing through one of the eyes of its two thread guides, as described, I claim the improvement of making one of the said guides, viz., the guide with the long slot for receiving the thread, in its passage to and through the other guide, as specified.

Also the above described peculiar mode of sewing cloth, or other fabric, viz., by combining two threads with the fabric, by drawing them through from the same side of the cloth and through each other's loops, interlooping them in plegma stitches, so that the threads alternately bind each other, substantially as specified.

I do not claim a hooked needle, having a contrivance, such as either a lever turning on a fulcrum applied to, or a needle or wire, made to extend and work through the shank of the hook, as is used in knitting machinery; but I claim the improved arrangement of applying the closing slide to the hooked needle, to the same side as the barb or hook, so that it may slide in a groove in the needle or carrier, parallel to the motion of the needle, in the manner specified.

S. L. Dana, of Lowell, Mass. (assignor to the proprietors of Locks and Canals), for an improvement in purifying Rosin Oil.

Claim.—I do not confine my claim to the use of lime as a base in the above process, although I prefer it; alumina, magnesia, potash, or soda, or oxide of lead, may be used in the proportion which their atomic weights bear to that of lime.

I claim the above described process, or its equivalent, of preparing a rosin oil, free from the peculiar and offensive odor which characterizes the rosin oil of commerce, by combining, as above described, the fluid formed by the first distillation of rosin or rosin oil, however produced, with slaked lime or other alkaline, earthy, or metallic base, equivalent thereto, as described, and distilling from the compound thus formed a deodorized preparation of rosin oil, as described.

Henry Bessemer, of Baxter House, England, Sugar Drainer. Patented in England, February 24, 1852.

Claim.—I claim the combination of the revolving and hollow spreading table formed with a wire gauze, or perforated top (and connected with an air-exhausting apparatus), the spreading mechanism, the water sprinkling pipe or its equivalent, the means of discharging the water and molasses, and that of removing the cured sugar, the whole substantially as specified.

Samuel Cook, of Brockport, N. Y., for improvement in Smut Machines.

Claim.—I claim the construction, combination, and operation of the fan, screening plate, and brush, in the cylinder, and the openings and tubes, or pipes, leading therefrom, when the fan is placed below, and the brush above said plate, so that the blast created by the fan shall be drawn through the plate, and also, when said cylinder is provided with discharge openings and tubes, for conveying off the full wheat, the lighter grain, and the dust, in separate directions, as described, and this claim, whether the same be affected in a single cylinder, or in two or more, so long as they are the same, substantially, in construction and operation.

Ezra Coleman, of Philadelphia, Pa., for improvement in Folding Envelopes.

Claim.—I claim, first, the lifter, which acts in the double capacity of taking the paper from the package to the folders, and holding it while the ends are being folded.

Second, the folder, in combination with the pedals, in such a manner as to hold the paper by the end folders pressing it upon the bed, while the sides are being folded, the connection between the pedals being through the medium of racks, pinions, and pulleys, or other analogous devices.

Third, the arrangement of the roller in combination with the handle, by means of arms, rock shafts and levers, or equivalent, so arranged that the simple action of raising and lowering the handle distributes the paste.

Fourth, the roller for the purpose of removing the paper after it has been folded, substantially as described.

Reuben Daniels, of Woodstock, Vt., for improvement in Straw Cutters.

Claim.—I claim the combination of a series of straight rotating blades, whose cutting edges are equidistant from and parallel to a common axis of rotation, and hence describe a cylinder when they rotate with a fixed blade having a curved edge given to it, as described, and corresponding to a line drawn obliquely on the cylinder, generated by the rotating blades, and set in a position coinciding with that line, when, by a series of straight knives on a cylinder, are made to cut obliquely or with a shearing cut, by the oblique adjustment of the fixed blade only.

Wm. P. Merriam, N. C. Harris, Wm. Wheeler, & E. N. Merriam, of Poultney, Vt., for improvement in Iron Candlesticks.

Claim.—We claim the mode of constructing candlesticks of sheet metal, as described.

James Bolton, M. D., (assignor to Chas. D. Yale, of Richmond, Va.,) for improvement in Hot-Air Furnaces.

Claim.—I claim packing the air-chamber, connected with any contrivance for heating the air which it contains, with spiral metallic scraps, or scraps of metal, bent into other shapes, by which the same effect is produced, these scraps being designed for the conduction of heat and absorption of radiant heat, whether they be loose, or connected with the adjacent walls or heating contrivance.

S. F. Palmer, New York, N. Y., for improvement in Canal Boats.

Claim.—I do not claim of itself the use of a wheel or drum, containing the spring upon which to wind a line, as I am aware that such drum, with spring, is in use, as applied to tape and clothes lines; but I claim the arrangement of the wheel with the spring wound upon its axle, and fastened to the frame, as described, in connection with the brake and the tow-line, as set forth.

T. J. Sloan, of New York, N. Y., for improvement in the manufacture of Screw Blanks.

Claim.—I do not limit myself to the precise manner of mounting and giving the required motions to the cutter, for forming the point on the blank, or the chaser, for forming the thread on the shank and point, as these may be varied by the substitution of mechanical equivalents.

I do not wish to be understood as making claim, broadly, to the combination of a cutter, for pointing with the dies, for forming the thread on the cylindrical part of the shank.

But I claim combining, in an organized machine, a cutter and its appendages, operated as specified, for forming the point on screw blanks, as specified, with the chaser or cutter, which cuts the thread over the shank and pointed part thereof, down to the point, as specified.

T. B. Stout, of Key Port, N. J., for improvement in Potato Diggers.

Claim.—In the above improvement I claim nothing separately, the cylinder, with its teeth attached, has been previously employed for other, if not similar purposes.

But I claim the cylinder with the teeth attached to its periphery, the combination with the beater and forked cutter, the cylinder, beater, and cutter being constructed and arranged in the manner as described.

S. D. Tillman, of Seneca Falls, N. Y., for improvement in Radiators for Stoves.

Claim.—I claim the entrance and exit passages on the same horizontal line of the radiator, or nearly so, and at or about the position of the line of the middle horizontal section of the radiator, when such arrangement of these passages is combined with a series of flattened tubes or air passages and horizontally winding smoke passages, as set forth.

Also, in combination with the vertical air spaces and smoke passages, formed by the flattened tubes, the successive contraction of the air spaces, in the manner set forth, that is to say, the air spaces varying in thickness or the width of their cross section, as they recede from the source of heat, each tube being of uniform width or thickness, throughout, but narrower or thinner than that which precedes it.

A. J. Watts, Utica, N. Y., for improvement in process of preparing Gold for Filling Teeth.

Claim.—I claim the described process of preparing or crystallizing gold, for the purpose of filling teeth, as set forth.

D. Marsh & B. Whitney, of Fairfield, Ct. for improvement in Rice Hullers.

Claim.—We claim the two dentated cylinders and the dentated beating arms running between them, to be used in connection with the above described machinery.

Chas. Ludwig Gran, of Hamburg, Germany (assignor to Conrad Poppenhusen, Brooklyn, N. Y.), patented in Germany, Dec. 15, 1847, for Ornamental Compounds.

Claim.—I claim the method of making artificial veneers, &c., by combining with saw-dust or the equivalents thereof, as specified, the curd of milk and lime, or its equivalent, after these latter have been triturated and thoroughly mixed and reduced to a semi-fluid state, as specified.

J. E. Crane, of Lowell, Mass., for improvement in Chain Cable Stopper.

Claim.—I am aware that a pawl or nipper has been hinged above the hawse hole, for the purpose of stopping the cable, by pressing it against the under side of the hawse hole, and I am also aware that a chain stopper has been described, which consists of two concave plates of iron, between which the chain passes, the lower one of the said plates being firmly secured to the deck, and the upper plate being turned upon the hinge, and the chain stopped, by pressing it tightly between the said plates, by means of leverage applied to the upper plate; and therefore I disclaim having invented the equivalent, in principle or action, of either of said chain stoppers.

But I claim the ridge, rising from the deck of a vessel, between the hawse hole and the windlass, combined with a heavy pawl placed above it; the said parts being arranged as described, whereby each moving link of the cable is turned flatwise, in passing over the ridge, and each link is acted upon by the pawl, as described.

Robert Adams, of London, England, for improvement in Revolving Fire-Arms. Patented in England Feb. 24, 1851.

Claim.—I claim combining with the frame and the hammer, the spring for holding the hammer back, as stated.

I also claim the sear attached to the trigger, by a swivel joint, and acting on the hammer, substantially as described.

I also claim the stop or projection on the trigger, for holding the chambers in position, when firing, as described.

Richard L. Hinsdale, of New York, N. Y., for improvement in Exercising Machines.

Claim.—I claim the bows on their hubs, and the strings and handles, either alone or in combination with the spring and vibrating platform, as described.

I also claim the elastic reciprocators made and operating as described.

Also the bows on the brackets, or their equivalents, either alone or in combination with the spring platform, for the purposes of vertical exercises, as described.

George Kendall, of Providence, R. I., for improvement in Mould Candle Apparatus. Patented in England Nov. 12, 1852.

Claim.—I claim, first, the arrangement of the travelling and fixed railways, on which the moulds are transferred from place to place, as required in the process of casting candles, in combination with an oven for heating the moulds, a melting pot to prepare the fat for casting, and apparatus for drawing the candles from the moulds, as set forth.

Second, in combination with a series of moving stands of moulds, I claim the counterpoised hooks, or the equivalent thereof, arranged and operating as set forth, to aid in drawing the candles and centering the wick in such a manner as to dispense with much of the care and skill heretofore required for the performance of this operation.

Third, I claim an elastic or a yielding cap for the lower end or tip of the moulds which performs the two functions of stopper, and the friction brake to stretch the wick, as set forth.

Fourth, I claim the wick clamp, constructed and operating, as set forth.

Daniel Reid, of Washington, N. C., for improvement in apparatus in Manure Carts.

Claim.—I claim the measuring valve apparatus beneath the lower hoppers, in combination with the said hopper for discharging manure in hills, as set forth.

G. W. Reid, of Evansville, Ind., for improvement in Corn Shellers.

Claim.— I claim the combination and arrangement of the sloping longitudinal slat screen, and the transverse slat screen, for the rapid and thorough separation of the corn from the cobs, as they are thrown from the concave by the shelling cylinder upon the said combined screens, as set forth.

P. J. Steere, of Cheshire, Mass., for improvement in Sewing Barrel Heads.

Claim.—I claim the finger, in combination with the movable shaft, for the purpose of converting the curvilinear motion of the saw into a rectilinear motion, as described.

J. S. Taylor, of Danbury, Ct., Machines for Shrinking Hat Bodies.

Claim.—I claim the process of shrinking or sizing hat bodies by passing them longitudinally into or through a chamber formed by placing several cylinders or rollers (having concave or other denomination of surfaces) in such proximity as to form the said chamber, as set forth.

C. N. Tyler, of Worcester, Mass., for improvement in Repeating Fire-Arms.

Claim.—I claim, first, arranging the cock in such a manner that it may be raised and will stand up, without being held by a sear or catch, and may then be gradually lowered again, without tripping to fire the charge, or may be tripped to fire the charge at the option of the operator, whether the devices employed be such as are described, or the equivalent thereof for producing the same result.

Second, the movable stop, operated upon by stud or button, protruding through to the outside of the stock, in combination with a fixed rest, and the jack, as described, for the purpose of preventing the jack being thrown far enough back to clear the tongue, through which the trigger acts upon it, whereby the escape of the driver or hammer, is rendered impossible while the stop is in operation.

Third, I claim the magazine constructed with a self-acting driver, which places the cartridges in succession in front of the discharger, and with a discharger that will draw itself back and place the pulling-rod in the proper position for transferring the cartridges into the breech, so that they may be transferred, as required, by simply pressing with the finger upon the pulling-rod.

S. R. Wilmot, of New Haven, Ct. (assignor to Joseph Kent, of Baltimore Co., Md.), an improvement to Apparatus for Drawing Water from Wells.

Claim.—I claim the projecting stud, in combination with the spring, and grooved pulleys, for the purpose of contracting the spring, by the weight of the bucket, and causing the pulleys to grasp firmly the way in the manner set forth.

Patrick O'Reily, of Reading, Pa., for improvement in Rails for Railroads. Antedated Nov. 8, 1852.

Claim.—I claim the divided or double plate rail, as described, which is composed of a flanged arch or bridged rail, of the usual form, and about half the usual thickness and weight, with another rail of similar external form, thickness, and weight, on which it rides, the under side of the arch of the upper rail or rider forming a groove to fit over and rest upon the arch or tongue of the lower rail, the flanges of the upper rail resting upon and fitting those of the under rail, and the spike holes of the two corresponding, so that the same bolts or spikes will secure them firmly together, and to the foundation, the compound rail thus formed and proportioned having a double bridge and a double base, the two portions of which reciprocally support and strengthen each other.

Also, the method described of strengthening the joints of the ordinary bridge or rail, while leaving its middle of adequate strength, by moving a longitudinal section of its inside equal to about half the weight of the rails, half its length endwise, so as to break joints with the outside, or constructing the rail in two parts, to correspond in form and position with the two parts of the inner half, where divided from the outer, and moved as aforesaid, whereby the joints of the upper rail are rendered as capable of supporting the load at its middle, and the whole made stronger, with a given quantity of material than by any mode of construction heretofore known.

J. D. Steele, of Pottstown, Pa., for improvement in Rails for Railroads, (assignor to C. E. Smith, of Philadelphia, Pa.) Ante-dated Nov. 8, 1853.

Claim.—I claim the construction of a rail in two parts, which is composed of a flanged ⊓ or bridge rail of the usual form, with another rail or splice-plate, of similar external form, on which it rides, the under sides of the arch of the upper rail forming a groove, to fit over the arch or tongue of the lower rail or splice-plate, and the flanges of the one overlaying and resting upon the flanges of the other, and the flanges may be riveted together, the spikes or bolts fastening the rails at large to their bearings, may be made to pass through the flanges, and thus perform the double office of fastening them together and to their bearings, and the interior rail may have a solid or hollow tongue or rib, and it may have a length sufficient to give it a bearing on three sills or cross-ties directly under and adjacent to the joint, or it may be equal in length to the upper or main rail and break-joints with it, as may hereafter be found most desirable.

RE-ISSUES.

L. F. Markman, of Cambridgeport, Mass., for improvement in Trimming Books, &c. Patented April 18, 1848.

Claim.—I claim a turning and adjustable book-holder, arranged and described, so as to be made to assume either of the three positions specified, and so that the three edges of a book may be trimmed, by a single adjustment of the same in said holder, and by the movement of said holder on its pivot, consecutively to each of the aforesaid three positions, whether such holder be combined with a reciprocating knife or cutter, having any other shape or motion.

Also the adjustable frame in combination with the trimming book-holder, or the turning and adjustable book-holder, for the purpose specified.

Also, the combination of the table, on which the book-holder is supported, arranged so as to be gradually raised, to convey the edges of the book to the knife, with a reciprocating knife or any other knife or cutter having any other shape or motion.

Benj. Chambers, of Washington, D. C., for improvement in Fire Arms. Patented July 31, 1849.

Claim.—I claim a hinged breech-piece, which is easily moved into and out of place, in closing and opening the gun, for the purpose of loading, swabbing, &c., substantially as described.

Also, in combination with a gun having a dissected screw-breech, the flanged shield through which the cartridge is made to pass into the chamber over the dissected screw, without danger of being broken by the ends and edges of the threads, as set forth.

Also, in combination with a rammer for charging guns at the breech, the projecting central point, whereby the cartridge, in being driven to its place in the chamber, is perforated at its base, to receive the point of the percussion cap, for the purpose of insuring the ignition of the gunpowder, as set forth.

Also, the enlargement near the shoulders, of the rammer, whereby the shield through which the cartridge has been rammed, is made to adhere by friction to the rammer, and to be drawn out of the breech of the gun, without requiring a separate operation for taking it out; in these claims I shall not confine myself to the exact arrangements of parts described, but shall vary the same at pleasure, while I attain the same ends by means substantially the same.

Benj. Chambers (assigner to Joanna Chambers), of Washington, D. C., for improvement in Cannon Lock. Patented July 31, 1849.

Claim.—I claim the method of securing the lock to the gun, by means of the sectional or quarter-screws, for the purpose of speedily opening or removing the lock, to supply it with a cap, pellet, or other material by which the gunpowder is ignited, and for firmly holding the same in place on the gun when it is to be discharged, as described.

Also, forming the gun-lock in such a manner that the hammer-rod and the percussion-rod shall be in separate pieces, laying axially within the same barrel, whereby the coiled mainspring is made to urge the hammer-rod against the head of the percussion-rod to discharge the piece, and the recoil spring on the percussion-rod, is made immediately to draw back and hold the valve which closes the interior of the lock, against access of smoke and gases, as set forth.

Wm. F. Ketchum, of Buffalo, N. Y., for improvement in Reaping Machines. Patented originally July 10, 1847.

Claim.—I claim, first, placing the cutter bar and cutters lower than the frame of the machine and opposite the side of the plane of the wheel, in such a manner as to leave unobstructed space below the frame, and also between the wheel and the cutter, with their supports, to allow the machine to pass freely and without clogging, over the cut grass or grain, as set forth.

Second, placing the cutters lower than the frame and axle, and in or nearly in the same vertical plane with the axle, on which the frame hangs and vibrates, and parallel, or nearly so, to said axle, so that the vibrations of the frame, on uneven ground, shall not materially elevate or depress the cutters, as set forth.

Third, the endless chain of cutters in combination with the guard teeth, as described.

The Norwalk Catastrophe—its Causes.

Since the issue of our last number an accident has occurred more appalling in its results than any which have preceded it within the present year; and although not traceable to any imperfection in mechanism or material, it seems to demand a considerable share of attention. As an example from which to derive a lesson, in which point of view we choose to regard the disasters continually forcing themselves upon our notice, the accident at Norwalk is really no more important than others less destructive of human life, but there are points connected with this catastrophe which are of peculiar interest in railroad management. The facts are briefly as follows:

On May 5th the passenger express train, which leaves New York at 8 A. M. for Boston, *via* New Haven, arrived at Norwalk some 8 minutes behind time, and without stopping, as usual, at the station, proceeded on around a curve, and plunged the locomotive, tender, baggage-car, one passenger car and a portion of another into an open draw. Forty-five persons lost their lives by this lamentable affair.

The rights of navigation being considered paramount to those of land travel, the draw is always opened when the approaching train is not within sight or hearing, and the draw-keeper has been entirely exonerated from all blame in the matter.

The engineer of this train was Edward Tucker, one of the most experienced and careful drivers on the road, and one who would have been among the first selected for any extraordinary emergency, requiring an extra display of those qualities. This was not, however, his regular train, being delegated to this position only to supply a temporary vacancy; but with all the peculiarities of the road, the signals, &c. Mr. T. was perfectly familiar. The signal ball was lowered at the proper time, some ten minutes before the opening of the draw, as distinctly testified by all the witnesses.

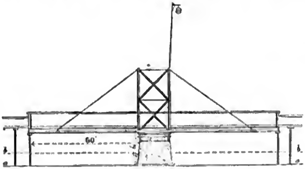
It is easy to conclude that there was either the most culpable carelessness on the part of the engineer, or an insufficiency in the arrangements for warning him of the danger. The simple fact that the accident occurred is sufficient to establish one or both these conclusions, yet the various opinions expressed by the press and the public generally indicate that it is one of those questions not to be so summarily disposed of. The signal, in fact, was exactly such as, had it not been already established, might be now proposed to remove all possibility of danger. A hollow frame, covered with red hunting, composing a conspicuous ball, whose *absence* should be the signal of danger, would seem to be a most effective signal; and, lest the draw *might* be opened without lowering the signal, the halyards were secured to the crank, so that by no possibility of sudden haste or excitement could the draw be moved without calling the signal to mind. The signal was down, but we shall see that there were several reasons, combining with an accidental inattention on the part of the engineer, to produce the deplorable result in this instance.

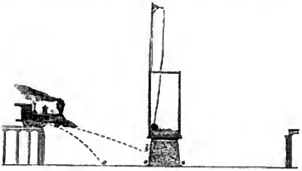
It was not shown at the inquest, or indeed suspected by any parties, as we are aware, that the engineer was in any degree intoxicated, or rendered by any other cause incapable of exercising all the ordinary and extraordinary vigilance required of the best locomotive engineers. The idea of a possible opiate has been suggested; but strong as has been the excitement of a deeply injured community in consequence of this accident, no one has seriously urged the probability of such a supposition. The man was probably in one of those accidental fits of "absence of mind" to which all are more or less liable; a state in which all the usual motions are performed mechanically, but without the clearness and nervous energy characterizing our usual actions. This is a condition altogether inexcusable in a locomotive engineer running an express passenger train, approaching a curve and drawbridge, yet the supposition is not merely the most charitable, but the *only* explanation of the difficulty.

There were three other causes conspiring with this temporary carelessness, or the result would never have been experienced. First, the curve in the road and a number of intervening objects shuts the signal out from view during a considerable portion of the immediate approach to the bridge. Second, the color of the signal had faded by exposure from a bright vermillion to a reddish-brown. The third, and principal, is the fact, that at the distance of some half a mile, the point where the eye of the engineer first meets this signal of safety, it is exhibited not standing out against the sky, but against a distant wood, any dark spot in which might, in the temporary stupid condition supposed, be taken for the signal. This is the theory we have formed, and confidently believe in, at the present moment. The only look at the signal was made mechanically, on first emerging from the bridge; at this distance, some dark spot in the background was made to answer the purpose, and the fated train swept on till near the bridge before the absence of the accustomed signal flashed on his lethargic brain.

The mode since adopted is, without doubt, the most effective in this respect which could well be suggested. Every train comes to a full stop before every draw-bridge. We would suggest that this precaution might be entirely dispensed with (except at Norwalk, where the curve renders it imperative), by simply raising the signal poles to a sufficient height, that the ball would always be displayed in contrast with the sky. It is in first coming within sight of the signal that the watchful engineer seeks a full and sure observation, after which other objects, equally his duty, demand his attention. The signal should be *very conspicuous*, and that *from the first point of view*. The results in this case, if due to the sources here suggested, show that this is a matter of grave importance.

A calculation of the velocity of the train, based on the well-established laws of falling bodies, would naturally occur to every one on first hearing of the accident. Several correspondents of the *Tribune* have arrived, by this calculation, at a result of over 40 miles per hour. All these assume that the locomotive struck the opposite pier at a point some ten or twelve feet below the level of the rails. This is apparently a very simple problem, but is, in reality, too complicated to rely upon. It would require a knowledge of what point of the locomotive thus struck, and how high this point usually stands above the rails, also an estimate of what portion of the machine would project over the chasm before commencing the descent; and lastly, the disturbing effect of a heavy train crowding against a reversed engine at the moment its wheels lose their hold upon the track. The springs being all compressed might exert a considerable force in projecting the falling mass, the couplings also might derange its fall, but above all the fact that the locomotive is not a point, but a machine of considerable volume; all these tend to complex the problem, and render it, to a great degree, inexplicable. The locomotive which made this plunge [No. 2] is 25 feet long, exclusive of the pilot or cow-catcher. The weight is distributed, 16 tons on the driving-wheels and 7 tons on the truck. It will be seen, that while it would not *commence* falling while any portion of the truck was supported, it could hardly be said to be in the condition of a body falling freely until past the position represented in the sketch. But the appearance of the locomotive proves very conclusively that it did not make the flying leap accredited to it. At the request of the engineer of the road we have perfectly satisfied our scruples on all these points by personal observation. The witnesses who reported the butting of the machine against the pier above water, were very naturally attending to the cars and their valuable freight of human lives, rather than the movements of the locomotive. The latter was found lying in mud up to about the centre line of the boiler, and with its cow-catcher very slightly injured, and pressing against the piles beneath the point *a* in our sketch. The tender was thrown, bottom upwards, upon the top of the locomotive, and, of course, destroyed the cab or house, and all the projecting objects on the top, but the under and front side is perfectly sound and needing no repairs. Neither the frame nor the smoke-box show any marks of collision with any object, and the cow-catcher is no more injured than might be expected from a very trifling contact with the piles on which the stone pier is founded. The proof is positive that the mass could not have struck at the point *b*, and brushed down past the projecting platform at *a*.





Adding four feet for the length of the cow-catcher, the locomotive is 29 feet in length. Our sketch was taken at low water. The tide was nearly full at the time of the disaster, and the path of the projectile would probably be more perpendicular after touching the water. Setting this, however, against the extra impulsive forces before alluded to, and assuming the whole to be collected in one point at its centre of gravity, and to assume the condition of a freely falling body when said centre passes over the edge of the draw, we may make an imperfect attempt to approximate to the speed of the train. The centre of gravity would be some 15 feet in the rear of the forward point, and this forward point must have struck below, and not above, the platform *a*, consequently the point *c*, where its path crossed the level of low water in the river, was at least 15 feet from the piles. The edge of the platform *b* projects about 3 feet beyond the perpendicular line from the top of the pier. The total leap performed by the mass, then, is $60 - 3 - 15 = 42$ feet, in falling about 20 feet. One element of considerable importance must be omitted, that is the position of the falling mass, whether inclined or otherwise, but there are reasons for supposing it to have fallen nearly in a level position, as otherwise the tender could hardly have been thrown in an inversed position upon its top. Assuming all these conditions, it is easy to find the velocity of the train. The time required by the train to travel the 42 feet equals that required by a heavy body to fall from rest 20 feet.

$$\sqrt{16} = 4 : \sqrt{20} = 4{\cdot}472 :: 1 : 1{\cdot}118 \text{ seconds.}$$

The time required to travel, with this speed, one mile, or 5280 feet, is

$$42 : 5280 :: 1{\cdot}118 : 140{\cdot}5485 \text{ seconds.}$$

And the miles travelled in one hour, or 3600 seconds,

$$\frac{3600}{140{\cdot}5} = 25{\cdot}62 \text{ miles per hour.}$$

This calculation, therefore, gives a result of between 25 and 26 miles per hour.

So far we have confined ourselves simply to an exposition of the facts, and prefer to leave the subject there, as our object will be fully accomplished by such a course. The New Haven road will compare favorably with the great majority of railroads in America, but this, so far from being an argument against its defects, should attach to them so much the more importance.

The possibility of accidents of this kind has been most fatally demonstrated by this example, and it becomes all parties interested to assist in reducing this possibility to the lowest practicable degree. The color of a signal of this kind cannot be depended on, nor can more than one glance be insured from the engineer, however capable and careful under usual circumstances.

We propose shortly to present in full some suggestions on the proper penalties for fatal accidents. We believe that, aside from severe criminal penalties for actual misconduct, heavy pecuniary forfeitures, previously fixed and understood by all the parties, would raise the profession of steam engineering, improve the men and raise the wages, facilitate the introduction of desirable improvements, and diminish the dangers of rapid travelling. Security, and not vengeance, is what the community desire.

It is not one year since a steamer on fire was run ashore on the Hudson River, and her captain, instead of staying to multiply the number of "injured," by reducing the number of dead, proceeded at once to this city to report progress. The engineer of that boat has now departed, we think, on a yachting excursion to Europe in the North Star, and no one believes that any further effective steps will be taken against those who, by unskilful if not criminal management, caused the disaster. The Norwalk disaster is by no means a similar case, and in no respect can it be ascribed to positive faults or criminal management.

Apprentices' Department.

Answers and Explanations of Questions on page 117.

ANSWER to question 11th:—

The width of the alley being 4 feet, or 48 inches and one side ½ inch higher than the other, the inclination of the plane transversely is 1 in 96. If the alley is 60 feet long, and the velocity of the ball 30 feet per second, it will take two seconds to roll down the alley. This motion being at right angles to that caused by the inclination of the plane, will not at all affect it. Now if the ball were placed upon the alley, in two seconds it would roll 0·67 inches from the centre, because 96 : 1 :: 64·33, the distance a body falls in two seconds, : 0·67. So the ball *will* hit the centre pin 0·67 inch from the centre of the pin. The weight of the ball is obviously immaterial.

CARPENTER'S APPRENTICE.

A grave error has crept in here. The 0·67 is *feet* instead of inches. Reduced to inches, the distance between the centre of the ball and pin will be $12 \times {\cdot}67 = 8{\cdot}04$ inches. The semi-diameter of the pin = 3 inches, added to the semi-diameter of the ball, which is 4 inches, leaves $8{\cdot}04 - 7 = 1{\cdot}04$ inches; consequently the ball will *not* hit the pin, clearing it more than an inch.

Answered also quite correctly by W. F. F., of Trenton, N. J.: "the centre of the ball will go 7·96 inches below the centre of the pin."

12th. Three hundred cubic feet.

The area of the large end is $3 \times 3 = 9$ square feet. The contents of a pyramid are found by multiplying the area of the base by one-third of the length. Consequently $9 \times 100 \div 3 = 300$.

Question 13 contains a misprint. The specific gravity of sea-water varies with the saltness, temperature, &c., but should be assumed at 1·026, instead of 2·026. The question, together with the 14th and 15th will be repeated. Question 14th is important, and of very frequent application, and the 15th is considered quite a knotty problem.

Questions.

Question 13.—Assuming the weight of a cubic foot of sea-water to be 1026 avoirdupois ounces, and assuming the sea to be of equal density at all depths, what is the pressure per square inch on the bottom at the depth of 7706 fathoms (about 8¾ miles, which were the soundings obtained by Capt. Denham, as detailed on page 87)?

For questions 14 and 15, see p. 117.

Question 16—A certain stream yields a constant supply of 40 cubic feet per second, and has a fall at one place of 16 feet, how many horse-power is it?

Question 17.—Assuming an undershot wheel to utilize 33 per cent. of the whole power of the water, what power might be constantly obtained from the above water privilege by a good undershot wheel?

Question 18.—The above suppositions are based on a continuous flow of water and continuous work night and day. But we wish to work only ten hours. Suppose, now, the water could be reserved in the pond during the 14 hours, none being wasted, how many horse-power could be obtained by a suitable undershot wheel during the working day.

Question 19.—A recently invented hammer includes a cylinder and piston affixed to the hammer, similar to the steam-hammer. But instead of admitting steam into the cylinder to raise the hammer, it is raised by a cam and lug on the piston-rod, thereby forming a vacuum in the cylinder, to give force to the return blow, which force is regulated by valves, &c. I want to know whether I gain or lose by having 100 lbs. hammer and 200 lbs. vacuum, or 300 lbs. hammer and no vacuum, allowing that the first hammer will return in one-third the time that the last one will?

Correspondence.

[For Appletons' Mechanics' Magazine.]

Car-Axle Boxes.

What constitutes a perfect axle-box? Retention of oil, exclusion of dust, and not being liable to get out of order on account of the component parts becoming lost or broken. Tims' box, which was the cause of the late Andover accident, depending upon a groove being turned on the axle for the retention of the leather to exclude dirt, ought to be abandoned.

Lightner's outside-bearing box was considered the best until recently, but it possesses the following objections: If the waste, in consequence of there not being enough, sinks below the bottom of the axle in the least degree possible; the journal fails to become lubricated, the box and journal become heated, the oil holes run together, no oil can arrive upon the top of the journal, and there being *no passage at the sides*, the oil, after filling the cells in the slide and oil-holes in the brass box, can go no further, and the oilman is obliged to stop pouring in; the object desired is not accomplished, namely, a quantity of oil to go down into the waste, to float it to the under surface of the journal. Construct a passage for the oil and you immediately remedy the difficulty, the train proceeds on its way, there is no crawling along to a siding to wait an hour or two. Suppose even if the oil-holes were *not* obstructed, the bearing rests so *hard* on the top of the journal, that no oil can spread itself upon it. This objection is remedied in Mr. Kettell's box by the passage for the oil into the bottom of the box.

Another objection to Lightner's box is, that the outside plate, which is retained by screws, is liable to drop off, allowing the composition box to slip out, whereby great injury might happen. Kettell's outside plate is not dependent upon screws, and cannot become displaced. It affords at all times easy access to the brass box by merely taking off the weight from the bearing. I do not say that Kettell's box can never become hot, as that cannot be said of any box, but when it should become so it admits of instantaneous relief, which is not the case with any other box. This constitutes its superiority, and ought to be generally known to railroad managers in our country. It is unfortunate for us that the English, having written over for our best oil-box should have had Tims' presented to them. As that being defective for the reasons above mentioned, it must in time fall into disuse in this country. The groove rendering the axle liable to break, as was shown by Mr. Colburn in your March number, I deem these remarks imperative, as we ought not to use boxes which occasion accidents and consume one pint of sperm oil per box per 484 miles, when we can have a better box for the same price, and which will only require one pint per box per 2485 miles.

Ithaca, N. Y. April 4, 1853. D. E. B.

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To the Editor of Appletons' Mechanics' Magazine.

Dear Sir:—If your correspondent in the April number of your Magazine will refer to page 155 of D'Aubuisson's Hydraulics, by Bennett (Boston, 1853), he will find an explanation of the phenomenon of the centre of a rapid stream being higher than the edges.

The law is known as Dubuat's. "*If, from any cause, a column of water, comprised in an indefinite fluid, or contained between solid sides, begins to move with a given velocity, the lateral pressure which it exerts, before motion, against the surrounding fluid, or against the solid walls, will be diminished by all that is due to the velocity of its motion.*"

It is a well-known fact, that the velocity of the water in the middle of a river is greater than that at the sides; consequently, according to Dubuat's law, the pressure of the water in the middle is less than that at the sides, and the column must be higher to maintain an equilibrium.

That an embankment should be more liable to give way when the stream flowing against it is rising is not at all strange, since the rise is due to the fact that the stream having increased velocity, the water cannot find a sufficient outlet, and *backs up*, causing the rise. The injuring power of the current is proportional to its velocity.

As to the third question asked by your correspondent, I must say, that I am at a loss to render any explanation, because I am not sure of the existence of the fact. I have never, in my practice, noticed that "the spout-holes in low ground slacken their running when the rise ceases," to any appreciable extent. Of course they diminish gradually as the river falls, but I do not think that any one has seen a spout-hole cease running suddenly or quickly, when the current ceases to rise.

Hoping I have not trespassed too much upon your space, I remain

Yours truly, F. R.

Philadelphia, May 4, 1853.

[The law here quoted, though disputed by Navier and others, is, if correct, only a generalization of the facts, and can hardly be called an explanation of them. The annunciation of the law is not remarkably clear; the lateral pressure due to any given velocity being somewhat obscure. We want more facts, critically recorded.—*Ed. A. M. M.*]

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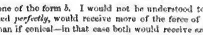
To the Editor of Appletons' Mechanics' Magazine.

Dear Sir:—Owing to absence from home I did not see the May number of your Magazine until yesterday, or I should have answered the questions in regard to my article before this late day.

In regard to the question as to the advantage to be obtained by using a slug of the form represented by Fig. 2, page 94, with the addition of the vacuum *c e d*, I can only say that I have used it to a slight extent, but its success did not appear to be such as to lead to its adoption; what results more careful experiments may elicit it is difficult to say. It is my impression that the advantage to be gained by using a shot conical behind will be found to be counterbalanced by the greater escape of propellant gas at the sides, for it is well known that more of a fluid will escape through an opening of the form *a* than one of the form *b*. I would not be understood to say that the slug, *if* it fitted *perfectly*, would receive more of the force of the powder if flat behind than if conical—in that case both would receive *exactly the same force*—but as we cannot get "a perfect fit," it must receive more than the other.



Your correspondent is, I think, wrong in considering the best form for the projectile to be that of a steamboat, or the solid of least resistance *for water*; the two fluids are essentially different, and the solids of least resistance vary not only with the fluid but also with the velocity, the form differing in proportion to the velocity, as R. G. H. will see by reference to the formulæ.

Alfred O. Blaisdell.

New Publications.

"Examinations of Drugs, Medicines, Chemicals, &c., as to their Purity and Adulterations." By C. H. Pierce, M. D., Examiner for the port of Boston. H. C. Baird, Philadelphia, 1853.

This valuable 12mo. volume, of 264 pages, is the joint production of the author and Dr. C. Linck, a graduate of the Giessen laboratory, and formerly assistant to Professor Horsford in the Chemical Department of the Lawrence Scientific School, the latter having added to various portions of the chemical details, and is solely responsible for the articles on alcoholic liquors, water, acidimetry, alkalimetry, chlorimetry, quinine, salts of tin, valerianates, ultramarine, and ether. Dr. Pierce himself is already widely and favorably known as the translator of Stöckhardt's Principles of Chemistry, &c. Methods are given in this work for testing the purity of drugs in general, all the most important chemicals, and some articles of food. The rigid examination of imported medicines provided for by act of Congress must, to a great extent, relieve the market from the importation of adulterated medicines, but affords no protection against their manufacture, or the subsequent adulteration of imported articles. This book is designed to supply, at a trifling expense, the information necessary to enable all to become, to some extent, proficient in examining for themselves.

"The Locomotive Engine." By Zerah Colburn. New edition. H. C. Baird, Philadelphia.

This eminently practical and useful little volume was originally published in Boston, in 1851, but is now reproduced in a larger form, to match the others of the "practical series." Its author, whose extraordinary faculty of intuitive calculation attracted much attention in his boyhood, now sustains the reputation of one of the best locomotive designers, and has treated the subjects in a style readily comprehended by the youngest apprentice. Beginning with a very brief treatise on steam, and omitting any attempt to record the history, it proceeds at once to detail the structure of every portion of an ordinary wood-burning locomotive, to give the rules for estimating its capabilities, and observations on its management. The author has presented in this work many facts valuable to all connected with railroad affairs, and touches briefly on the principal modifications and improvements, many of which have been introduced within a very few years. This modest little volume is by far the most valuable work on locomotives yet completed in America, and its low price (75 cts.) justifies us in recommending it to every engineer, fireman, or machinist employed either in their construction or management.

"American Dictionary of the English Language." By Noah Webster, LL. D., Revised and Enlarged by Prof. C. A. Goodrich. Springfield, G. & C. Merriam, 1852.

Webster is now generally acknowledged as the standard, and this Dictionary, unabridged, should be in the library of every speaker, writer, *or reader.* Credit is alike due to the labors of Dr. Webster and the enterprise of the publishers for this most valuable and low-priced volume. We cannot but regret, that in the careful revisions and additions which this book has received, the technical and general terms employed in the mechanic arts were not included. This has been attempted, but very imperfectly, in the present volume.

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Monthly Notes.

On the Caloric Engine we have little to add. The cylinders are being taken out of the Ericsson to go in again with the new heaters. The Evening Post engines have not been put in use, the proprietors of the Post having given permission for them to be sent to France as models. The patent law of France (a special exception to which was made in this case), provides that the introduction of machines of *foreign manufacture* destroys the patent, and the singularity of their being sent to France under these circumstances has induced a supposition that they proved insufficient for their legitimate purpose. Several small working models, supposed to be about 4 horse-power, have been lately constructed, and have, we believe, proved satisfactory; but with this exception, the experiments appear to be considerably more backward than at the date of our last issue.

Our last issue contained on page 117 a labored editorial on this subject. A contemporary has displayed, in attempting to review the latter portion, a full column of English language which we must decline criticising. The argument, if we can find any, is the supposition of the much sought-for mechanical equivalent of heat, which we are told every apprentice knows to be lifting 50 tons one foot with one ounce of coal. Such guides as these do more to retard practical science, by inducing a like conceited ignorance in the really earnest reader, than can well be imagined. There is, in fact, supposed to be a definite amount of mechanical work, which is the ultimate effect of a given amount of heat, for which see the labors of M. Clapeyron in France, Holtzman in Germany, and Joule in Great Britain, but this amount has never been ascertained with any degree of certainty. If by using the same heat many times over (which was not contemplated by these experimenters), this limit could be reached, or even approached, such arrangement would many fold exceed in economy the most perfect contrivance yet elaborated by man.

We will here submit a question and invite responses from any who imagine they can grasp it, viz.:

Suppose all the obstacles to the perfect and economical transfer of heat removed so that *all* the heat in a cylinder full of steam could be transferred from the exhaust to the contents of the steam-pipe (or to use the language employed on page 117, transferred from the outgoing to the incoming medium), what would be the total mechanical effect of a unit of heat?

We have supposed steam the medium because more familiar, but this theoretical condition is equally supposable with regard to air, and is of course presumed to be more so. Let us hear some thoughts on this question. We have stated our own on page 117.

The Crystal Palace progresses quite slowly; the machinery department being not yet raised. An advertisement on our cover sets forth quite fully the prospects for opening, &c.

The clipper ship "Northern Light," arrived at Boston May 29th, in 76 days from San Francisco, the quickest passage yet. This ship was absent from Boston only seven months, making the passage in that time to San Francisco and back. The "Sovereign of the Seas" arrived May 6, performed the passage from the Sandwich Islands to this port in 82 days, sailing all one day at the extraordinary rate of 28 statute miles per hour.

The Arabia, on her last passage to Liverpool, performed the passage in 9 days 22 hours, deducting the difference in time and a slight detention to recover a man overboard. This is, we think, the first passage performed by the Cunard line inside of ten days.

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To Readers and Correspondents.

The paper by Capt. Ericsson, on pages 121–123, will be studied with much interest. It is the only elaborate exposition of the caloric engine which has appeared under the authority of his name (that accompanying the plate in the February number being comparatively simple). A discussion between such engineers as those now engaged cannot fail to be instructive, and to finally develop a full and correct theory, provided the *subject* is adhered to, and personalities discarded. In this respect the paper in our April number was particularly worthy of admiration. The terms "analysis of absurdities," "smatterers," &c., employed in this number, will carry a force only in proportion as their justice may be established; and the fling at "theorizing in the absence of practical information," is altogether gratuitous. It is at least twenty-eight years since the hot-air engine was in frequent operation in the yard of Messrs. Braithwaite & Ericsson, to say nothing of other manufacturers, and the world has a right to be impatient. If any one, whether possessing all the data or only the limited stock now in possession of the scientific world, can point out *correctly* the effect of various dimensions, velocities, proportions, and conditions on the power of the caloric engine, and show in figures exactly where and how far the engine is applicable, that man, in preference to any other, deserves to rank with James Watt, or at least, with Count F. M. G. De Pambour, in the future history of practical science. May we hear from Major Barnard again.

Mr. D. K. Clark, the author of the paper on locomotive boilers, which forms the subject of the interesting report on pages 125–128 is well known in this country as the author of Clark's Railway Machinery, now publishing in numbers by Messrs. Blackie & Son.

K. T. M., of N. H.—The simplest "fire-annihilator" which we have seen described, promising to be at all effective, is sulphur. An insurance agent at Troy recommends it as having been effective in one case in saving his property. The principle on which it depends is the superior affinity of sulphur for oxygen, or, in other words, its superior combustibility. The sulphur robs the surrounding objects of the vital air, and converts it into sulphurous acid gas.

"L.," of N. J.—The most convenient method of inducing the spheroidal condition of water at ordinary temperatures is by smoking the surface on which it lays. The drops of water lay on soot more perfectly than on any dusty surface.

C., H. & F., of N. J.—You will find in an article in this number, on Carbonic Acid, all the information you require.

"Subscriber."—The present "Princeton" has the same engines, Ericsson's semi-cylindrical, but an entirely new hull.

J. P. H., of Penn.—Yours will appear in our next.

C. P., of N. J.—We have examined your article once and decided to decline it, but, by your leave, will keep it for another reading.

G. P. C., of N. Y.—"Can you inform me on what day Robert Fulton was born?" We cannot; can any of our subscribers? He was born, so say the biographies, in Little Brittain, Lancaster county, Penn., in 1765. If any one living knows the day, let it be permanently recorded, before a further lapse of time blots the information out of existence.

W. S., of O.—The passages of our steamships should always be published in mean time, and the miles per hour in nautical miles. A great part of the confusion would thus be avoided. The absolutely shortest passage yet accomplished between this port and Liverpool, according to Stuart's Naval and Mail Steamers, was by the Arctic, in 1852. She left her dock in New York at noon on Sunday, February the 8th, arrived at Liverpool at 10 o'clock on the morning of Tuesday, 17th, being 9 days 22 hours apparent time. Deducting from this 4 h. 48 m., for difference of longitude, makes her time actually *nine days, seventeen hours, and twelve minutes.* This we make no doubt is *the* quickest trip. The shortest *apparent* time in which the passage across has yet been performed is 9 days 13 hours, by the Baltic, which left Liverpool August 7th, 1852. Adding the difference in time makes her passage really 9 days, 17 hours, 43 minutes, mean time, or about half an hour longer than that of the Arctic.

APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 7.—Vol. III.—JULY 1st, 1853.

INCLINED ENGINES OF THE FERRY-BOAT MANHATTAN.

[See Plate 6.]

The style of engine of which the Manhattan is a type, was designed by C. W. Copeland, Esq., of this city, and patented in 1841, his specification allowing for a considerable variety of modification of the details and proportions, but covering the three principal peculiarities, which are as follows: 1st, the inclined cylinders and their combination with the condenser; 2d, the horizontal or slightly inclined air-pump and method of working it; 3d, the arrangement of the valves without lifting-rods. The valves are balance-puppet, and are usually provided, as in this example, with the adjustable Sickles cut-off.

The inclined engine, substantially in this form, has been applied to most of our late war-steamers, and to a number of merchant vessels for various purposes. The Missouri, burned in the bay of Gibraltar in 1843, was the first; the Michigan, now cruising on the lakes; the Susquehanna and Powhattan, the only first-class war-steamers in the American navy; the Saranac, second class; and the Scorpion, sold out of the service in 1848, and now running on the Law line on the Pacific, have each single inclined engines with riveted-iron framing. To these may be added the U. S. steamer Water Witch, and the Falcon, now running between New Orleans and Havana.

The Powhattan differs from the usual construction in having a vertical air-pump, worked by a bell-crank lever. The Susquehanna, Powhattan, and Scorpion, are provided with the Stevens cut-off, made adjustable by Mr. Copeland.

The Fulton, the third war-steamer of that name, and now considered the fleetest steamer in the U. S. Service, has also a single engine of this style, but with wooden framing.

A steamer lately built for Mr. Law, and designed for ocean service between San Francisco and Panama, is now lying at the Morgan Works in this city, to be fitted with two of these engines with iron frames; and in addition to the ferry-boats on the Fulton, South, Catharine-street, and Wall-street ferries in this city, two will soon be running as ferry-boats at Albany, three at East Boston, two at New Orleans, and two as general packet-boats on the Ohio river.

The value of this construction for ferry-boats is readily appreciated, the space below deck being of no value. Also for war purposes, the low position of the parts rendering them almost invulnerable to an enemy. There are now in use in American steamers, or in process of construction, between 30 and 40 of these engines.

The following references may assist the amateur.

K K, keel, *T T*, frames of hull,
A A, keelsons and bed timbers,
A' V, inclined frame of white pine.
y y y, supports and braces of same.
C, cylinder. *c f*, cast-iron framing of cylinder.
p r, piston-rod. *c h*, cross-head.
g', slides. *C r*, connecting-rod.
x, main shaft. *c k*, crank.
A p, air-pump. *h*, air-pump rod.
g, air-pump links. *l*, air-pump lever.
r, rods connecting air-pump lever with cross-head.
B p, *b p*, bed-plate. *a ch*, air chamber.

d p, discharge-pipe
v s, bonnet covering a hand-hole through which access is obtained to the foot-valves.
s p, side pipe.
st ch, *st ch*, steam-chests.
d d, ports connecting steam-chests with cylinders.
i i, rock-shaft framings carrying four rock-shafts.
r a, principal arm of rock-shaft, receiving its motion from
e c, *e' c'*, jointed eccentric rod.
c a, an idle lever supporting eccentric rod.
o' o'', links connecting arms on each of the four rock-shafts
c o, *c o*, dash-pots containing a plunger and oil or water to check the descent of the steam-valves.
n, exhaust-pipe leading from steam-chests, or rather from exhaust-chests, to
D, condenser.
q, main pillow block. *e e*, eccentric.
t, standard or column supporting the air-pump.
m, stediment to air-pump rod.
S S, throat castings.
L, deck timbers.
z, bolt and transverse beam connecting the larbnard and starboard frames.
W, outline of paddle-wheel.

The chief dimensions of the engine of the Manhattan are: diameter of cylinder, 34 inches; stroke of piston, 9 feet; diameter of paddle-wheels, 20 feet 4 inches; buckets, 4 feet 6 inches by 2 feet 2 inches.

On Iron, and some Improvements in its Manufacture [*]

Read at a meeting of the Institution of Mechanical Engineers, Jan. 26, 1853.

BY MR. J. D. MORRIES STIRLING.

The following remarks will but slightly touch on the ores, chemical composition, and general manufacture of iron; these subjects being greatly too important to be treated of in a communication like the present, and requiring much more research and time than the writer can at present devote, even did he feel himself qualified to undertake the task.

It is most desirable that these subjects should be thoroughly studied, as we are certainly more ignorant of the nature and qualities of iron, and of the differences produced by slight modifications in the mode of manufacture, by varieties of fuel, ores, fluxes, &c., than we are of the nature of any other article of manufacture; and it is to be regretted that, in a district like this, where iron manufacture is all-important, so little has as yet been done to elucidate the theory and to improve (on scientific and unerring grounds) the general make of iron, which the writer believes is only to be accomplished by our becoming thoroughly acquainted, as well with the chemical constituents of the various ores, fluxes, &c., as with the changes which these undergo in the various processes of calcining, smelting, refining, and puddling. To do this is probably not in the power of those actively engaged in the making of iron, as their other pursuits would materially interfere with the carrying out the necessarily long series of experiments which would be requisite; and, even could such time be devoted to the pursuit, then we should only have, in all probability, the results of trials made in one district.

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[*] From the London Artisan.

There is no doubt that many most valuable improvements have been introduced (more especially of late years) by ironmasters and others connected with the iron trade; but these have chiefly had reference to the later stages and finishing processes in iron-making, and to the machinery connected with these processes. Of the chemistry of the blast-furnace, of the changes produced by the process of refining, and in puddling, we are still ignorant. Having devoted a good deal of time to this subject, the writer may be allowed to say, that the more he has studied it, and the more he has seen of iron-making, the more convinced he is of our ignorance; and it is to be hoped that some steps will be taken to improve our knowledge, and render the various processes certain and economical.

The improvements in iron manufacture which are touched on in the following remarks are not of the nature of those alluded to above; they are of an inferior class, and should properly be called improvements in iron, or in the manufacture of certain kinds of iron for certain purposes. It will be unnecessary to enter minutely into the various processes for converting the iron ore into cast and malleable iron, or to describe at length the various materials used.

The chief varieties of iron ore which are used in this country are the clay-band, the black-band, and the hematite. From the hematite the purest pig-iron and strongest bar-iron are said to be made; and from clay-band a stronger malleable iron is generally supposed to be obtained than from the black-band; but the various qualities can be altered by the judicious ironmaster, and malleable iron of as good quality can be produced from black-band as from the hematite or clay-band. The writer does not here allude to improvement of quality by mixing different ores (by which it is well known the bad qualities of some descriptions are entirely removed), but to the skilful treatment of one or more ores of a somewhat similar character.

The first stage in the manufacture of iron is the conversion of the ore into cast-iron, which is accomplished in various ways. In Great Britain, the ore, after being calcined, if necessary, is introduced, with layers of coal or coke and a flux (usually a carbonate of lime), into a large furnace, and a strong blast (either hot or cold) is urged through the previously kindled mass, to accelerate the combustion of the fuel, and the conversion and fusion of the metal, which is usually tapped from the furnace once in the twelve hours, and run into pigs or ingots, which go by the name of "hot or cold blast iron," according to the nature of the blast employed. The subdivisions of both these sorts of iron are the same, viz.: No. 1, 2, and 3, when for foundry purposes, and forge or white iron, when intended for being converted into malleable iron; these numbers and qualities of iron are supposed to differ from each other in the quantity of carbon contained in each, although this is doubted by many eminent chemists. No. 1 is certainly, darker, softer, and more carbonaceous-looking than the other numbers, and forge or white iron appears to contain much less carbon than any iron intended for foundry purposes; but, as we see a similar effect produced on foundry iron by rapid chilling to that produced in forge iron by the supposed abstraction of carbon, it will, perhaps, be more readily admitted that color is not a test (or at least not a certain one) of the quantity of carbon which iron contains.

It may be here remarked, that the Nos. 1, 2, and 3 give *no real idea* of the nature of the iron; they are relatively comparative, and only indicate the *differences between cast-iron of the same district and make*; thus, what is called No. 1 in Wales resembles hard No. 2 in Scotland, and corresponds to Staffordshire No. 2 (average); Welsh No. 2 is fully as hard as Staffordshire No. 3, or Scotch No. 4 (a brand), intermediate between No. 3 and forge iron. As a general rule, Nos. 1 and 2 are adapted for small castings, Nos. 2 and 3 *mixed* for medium castings, and No. 3, or 3 and 4 in Scotland, or 3 in England, for heavy castings; but the mixtures of Welsh and Scotch, or of Staffordshire, Welsh, and Scotch, are found to make stronger and better castings than those made from one sort of iron.

This mode of producing strong castings has been long practised, and is in many places convenient; and the increase of strength is no doubt satisfactory; but there is still a want of uniformity in result, and an occasional difficulty in keeping to the proportions, and even in obtaining the brands specified by the engineer or architect, or chosen by the founder on his own experience.

It seemed to the writer very desirable, therefore, to obtain, if possible, a kind of iron which should be either uniform and constant in its strength, or, at least, *not under a certain standard*, and, after numerous experiments and trials, he attained this object by making certain mixtures of cast and wrought iron, which have been called "toughened cast-iron."

Allusion has already been made to the different numbers of cast-iron, and to their qualities; and it ought further to be stated, that No. 1 is considered the weakest, and No. 3 the strongest. To render these uniform in strength, and at the same time to equalize *that of cast-iron from different districts*, it is only necessary to vary the quantity of wrought-iron introduced, by which means all other mixture is avoided, and so much greater strength insured, as to allow a margin for considerable variation in strength, from any accidental defect, as well as for a diminution in weight, taking the averages of the toughened cast-iron and of the best mixtures:

*Transverse strength of bars, 1 inch square, 4 feet 6 inches between supports.**

Cast-iron, average breaking weight,........................436 lbs.
Toughened cast-iron, ditto, ...783 "

*Tensile strength.**

Cast-iron, average breaking weight,.................... 7·086 tons.
Toughened cast-iron, ditto, ...11·790 "

Crushing strength.

Cast-iron, average crushing weight,....................38·582 tons.
Toughened cast-iron, ditto, ...59·522 "

To render the above more intelligible, the proportions are given below, which have been found to bring very soft Scotch (No. 1 hot-blast) and very hard Welch (No. 2 cold-blast) to nearly the same strength.

Scotch, No. 1 hot-blast, breaking, when unmixed, at.......... 430 lbs.
With a mixture of 33 per cent. of wrought-iron scrap, broke at 718 "
The same Scotch iron as the first, with only 20 per cent. of malleable scrap, broke at about............................ 620 "
Showing a deficiency in the quantity of the scrap.
Welch, No. 2, cold-blast, breaking, when unmixed, at........ 440 "
With a mixture of 10 per cent. of wrought-iron scrap, broke at 659 "

The results obtained by Mr. Hodgkinson are very favorable, as shown in the following table, where the breaking weights of common cast-iron and toughened cast-iron are given, from the report of the commissioners appointed to inquire into the strength of iron.

Table of Comparative Strength of Cast-Iron.

Description of Iron Bars, all two inches square.	Transverse Breaking Load, in Centre.	Tensile Breaking Strength.	Crushing Strength.
	lbs.	Tons per inch.	Tons per inch.
Toughened cast-iron, with 20 per cent. wrought scrap...	2,174	11·50	54·64
Low Moor, No. 1,.............	1,207	5·67	27·80
Blaenavon, No. 2,............	1,220	7·46	49·11 50·50
Warrington best gun mixture,	1,375	—	—

Comparative trials, on a larger scale, made by Mr. Owen (by command of the Admiralty), gave equally satisfactory results. Tensile strength, according to Mr. Owen, 12·50 tons.

Since these experiments and trials were made, the toughened cast-iron has been successfully used in the construction of several public works, Windsor bridges, Chelsea bridge, Yarmouth bridge, &c., &c.: and it may be mentioned that, by being allowed to reduce the scantling in proportion to the increased strength gained by employing the toughened cast-iron, the contractors for the heavy castings of the Manchester viaduct were enabled *profitably to fulfil* their contract; whereas, had they used common iron, and been confined to the specification, they would have been heavy losers.

For shafting, rolls, pinions, cog-wheels, cast-iron railway-carriage wheels, cylinders, and other castings where strength and closeness of texture are desirable, the toughened cast-iron will be found most useful; also cast-iron, which will not chill in its unmixed state, readily chills, with less loss of strength than usual, when mixed in proper proportions with malleable iron.

To insure that the proper proportion of malleable iron is contained in each pig, and also to render the mixture more easily conveyed from place to place, the writer prefers making the mixture at the blast-furnace; and this is done by distributing the proper weight of malleable scrap in the moulds into which the melted iron is to be run. It is thus firmly fixed, and melts more easily and regularly with the cast-iron in the cupola or other furnace, the cast and wrought iron heating gradually to the melting point of the former, when the wrought-iron is easily acted upon, and fluxed by the cast-iron.

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* The averages of the transverse and tensile strength are from the experiments of Mr Hodgkinson, in the government report and elsewhere, and other experimenters; Mr. Hodgkinson is the sole authority for the resistance of crushing force.

The process of converting cast into malleable iron is much more varied than that of converting the ore into cast-iron. In some districts a great proportion of the cast-iron is refined previous to its conversion; in others little refined iron is used, and in some works cast-iron is at once converted into malleable iron; and this latter process seems to be gaining ground.

Refining is, perhaps, the least understood, and the least capable of being explained, of any process connected with iron manufacture. The iron is kept in a fluid state in contact with carbonaceous matter exposed to a blast, and, although it would seem that by such means more carbon *ought to be combined* with the iron, experience shows that a great change is produced in the nature of the metal, and that, as far as we know, the *quantity* of carbon is *diminished*, and the iron rendered more nearly akin to malleable iron, or at least so altered as to be more quickly converted into it.

Refining is an expensive process, great waste of material being unavoidable, but it is still necessary for certain descriptions of iron, and the expense is partly compensated by the greater quickness with which the conversion takes place in the puddling-furnace.

Puddling is the last and most important process in the conversion of cast into malleable iron. It is still an extremely rude one, and its theory is not understood; it consists in melting, in a peculiarly-constructed air-furnace, refined or cast iron, or a mixture of them, and, as soon as the fusion is complete, in continually stirring the melted metal till spicular or granular particles show themselves. Previous to this the melted metal swells up, and what is technically called boils; gas is evolved, and this appears to be the period at which conversion commences: the solid particles increase in quantity, and the whole mass acquires a semi-solidity; the workman keeps collecting the more solid portions and forming them into balls, which become larger and larger, until the whole of the malleable iron is collected, and nothing remains but what is called cinder, in a perfectly fluid state, which is afterwards removed from the furnace by tapping, and again used in certain proportions along with ore in reproducing cast-iron. On the removal of this cinder from the iron, by puddling, squeezing, and rolling, the quality of the resulting wrought-iron very much depends.

To avoid the process of refining, to shorten the process of puddling, and to improve the quality of the resulting wrought-iron, are, undoubtedly, most desirable. The writer has endeavored to accomplish this, and has reason to believe that partial success has attended his efforts. Instead of using refined iron, a mixture of wrought and cast iron (as already described) is taken, and, after being melted and run into pigs or slabs of the requisite size, it is puddled in the usual way, and the process of puddling is found to be thus so shortened, as to allow of from one to two heats more being brought out, in the course of the twelve hours; the yield is greater, and the quality of the iron is much improved, as regards fibrousness and tensile strength, rendering such iron particularly well adapted for cable iron, tension bars, shaftings, axles, &c., but not for the wearing surfaces of rails, nor for the tires of wheels.

Before proceeding to touch on certain other processes, which the writer believes to improve iron for special purposes, it may be well to point to some alloys of cast-iron, as the making these led him to make the addition of the same and other metals to wrought-iron.

The first is an alloy of iron and tin, which is extremely hard, sonorous, and capable of receiving a very high polish; the addition of manganese, and a very small percentage of zinc, gives somewhat greater tenacity. Bells made of these alloys have a pure and clear tone. Cast-iron will take up from 20 to 25 per cent. of tin.

Cast-iron alloyed with zinc becomes closer in its texture, and, as far as the writer's experiments have yet gone, stronger, and not less malleable. Alloys of bismuth, antimony, copper, and silver, possess some scientific interest, but it would be out of place to touch on them now.

Having observed the hardening effect which tin produces upon cast-iron, the writer tried a similar mixture in the puddling-furnace, and found a corresponding result, with this essential difference—that whereas cast-iron will take up about a fifth of its weight, wrought-iron is rendered too hard for subsequent working by any quantity exceeding one per cent.; and taking the various descriptions of iron (Staffordshire, Scotch, and Welsh), one-half per cent. of tin produces a description of iron crystalline, close in texture, and harder than common wrought-iron.

This quality of iron appeared to be suitable for the wearing-surfaces of rails and tires of wheels, and subsequent trials which have been made have fully confirmed this opinion. Lamination is prevented, and the rail, when properly made, wears smoothly and evenly. As in all iron, and particularly in rails, much depends on manufacture; but points and crossings made of this hardened iron, and rails upon sharp inclines, where the wear previously had been very rapid, have been found to last more than double the time of any rails previously tried, and, as they are yet not worn out, it is at present impossible to say how much longer they will last. The writer does not believe their increased duration to arise solely from the *greater hardness*, but more from the peculiar crystalline texture and fine grain of the iron resisting the lamination, which great speeds and heavy engines so rapidly produce. The sections of the rails show the proportion which it is considered best that the crystalline should bear to the fibrous iron, or to whatever other iron the rail may be composed of.

The addition of zinc, its oxides and other ores, produce the very opposite effect to tin and the other metals above named. Iron of what is called cold-short quality is rendered, by this means, fibrous, tough, and strong; red-short iron is also improved in quality by the same means, but it is found that a larger addition of zinc, or its ores or oxides is required to effect an improvement in red-short than in cold-short iron. The quantity necessary to improve cold-short iron varies much in different districts, and each peculiar iron requires to be separately considered; it is also necessary to know the percentage of zinc in the ore, if ore be employed, and to ascertain that such ore does not contain foreign matters, which might counteract the effect of the zinc. The addition of these metals to the iron is best made when the iron in the puddling-furnace is beginning to boil.

The writer was much gratified to observe in the American department of the Great Exhibition a confirmation of his experiments on this subject; iron, naturally cold-short and red-short, being rendered free from each of these qualities by the addition of an ore of zinc. Samples in all stages of progress were exhibited.

Table of Comparative Strength of Wrought-Iron.

Description of Iron.	Tensile breaking strain.	Deflection with strain of 2½ cwt.	Permanent set, in lengths of 2½ feet.	Final stretch, in length of 3 feet.
	Tons p'r in.	Inches.	Inches.	Inches.
Hardened wrought-iron, with ½ per cent. tin	23·92	1·42	1·02	¼
Toughened wrought-iron......	27·81	....	....	....
Dundyvan's best bar..........	24·88	2·02	1·60	2½
S. C. Crown average result	24·47	....	....	....
Hartley's general average of bar-iron	23·33	....	....	....

Had the limits of a mere sketch like this permitted, the writer would have entered on the consideration of the relative qualities of cold and hot blast iron, and of the effects produced by the use of cinder; also, on some combinations of iron with the earthy bases, and on the effects of various salts and fluxes in the blast and other furnaces. Several other alloys of iron possess considerable interest, and, in conclusion, allusion may be made to a remarkable property which iron possesses of closing the grain of other metals and alloys to which it is added in minute quantity.

Mr. Stirling exhibited a number of specimens of the toughened wrought-iron in bars, and the hardened wrought-iron, as applied to the surface of rails, showing their fractures, and specimens of the toughened cast-iron, showing the mode of mixing the wrought-iron scrap with the pig metal; also specimens of an alloy of zinc, copper, and tin, and another of the same composition, with an addition of 1½ per cent. of iron, showing the great closeness and fineness of grain that were produced by this small admixture of iron. It was explained that it was advisable to alloy the iron with the zinc before mixing with the copper, otherwise, there would be imperfection and unsoundness in the metal, the iron appearing in the form of what are technically called "tears."

The Chairman said he considered it a very important subject, and thought the paper showed valuable results of extensive practical trials combined with scientific inquiry. He asked at what period the tin or zinc was added to the wrought-iron.

Mr. Stirling replied, that it was put into the puddling-furnace when the extreme of the boiling was just passed, or passing, and conversion just commencing, and the formation of spicula beginning. A more fluid iron required the metal to be put in at a later period, and iron that came to mature sooner required the metal put in earlier. It was difficult to give a definite rule, it could only be judged of by particular experience.

Mr. Duclos thought the presence of zinc in the iron was doubtful; from its volatility, the greater proportion would probably be dissiuated in the furnace. He considered it more probable that the change n the iron was caused by the physical quality of the iron undergoing some alteration in consequence of the presence of zinc.

Mr. Stirling said he did not consider the mixture of zinc with the iron to be in all cases an alloy, as the proportion was occasionally only ¼ per cent., and he felt uncertain about its mode of action; the quantity of zinc required varied very much; it had to be determined by experiment with the different ores and furnaces.

Mr. Duclos observed that in some iron works he had been acquainted with in Belgium, he had never found any trace of zinc in the iron made from ore containing zinc, but metallic zinc was found to accumulate in the top of the furnace. Many years since a series of experiments had been made by M. Carsen on various mixtures of iron with zinc and other metals, but they had not led to any practical application. There was no question that sufficient attention had not been paid to the properties of the alloys that can be made with iron, and he was glad to see the steps taken by Mr. Stirling; he did not quite agree as to the want of knowledge of the iron manufacture, he thought there was a great deal of knowledge on the subject, but he would wish the principles carried out further.

Mr. Stirling remarked that, in the case mentioned, in Belgium, two processes—smelting and refining—intervened, by which most, if not all the zinc might be volatilized. There was no doubt that the practical making of iron was well understood, but not the theory and principles, otherwise the process might be further simplified, and, as the result, iron would most probably be produced complete at one process, instead of two or more. He thought that further improvements would be more studied and accomplished when iron and coal were dearer.

Mr. M'Connell said there was great room for improvement in railway tires and rails. If the tire now lasted 70,000 miles on the driving-wheel of the engine, it was considered very good work. The expense of replacing tires, and the failure, was a very serious item; and if, by Mr. Stirling's process, the iron could be made to last longer, it would be a great source of economy and convenience.

Mr. Beasley inquired why the wrought-iron scrap was put into the pig mould, in making the toughened cast-iron?

Mr. Stirling replied, that one object was to insure a definite proportion for each charge; also, the wrought-iron melted more easily in the furnace, when mixed in that manner with the cast-iron, which seemed to act as a flux, the whole getting heated together; the cast-iron dropping, eats away the wrought-iron. If thrown separately into the cupola, part of the cast-iron would melt down first, and the two would not get uniformly mixed; the wrought-iron was liable to get oxidized, and wasted.

Mr. Beasley observed, that he was aware if the wrought-iron was thrown into the puddling-furnace with the pig, it would burn away and not improve the quality; but if it was thrown into the fire a little time before the puddler commenced balling his iron, it would very much improve the quality.

Mr. Stirling said that it was an old practice to add wrought-iron in the puddling-furnace, in order to get a quicker yield; but it would not melt thoroughly in that case, and make a uniform mixture. It should be first re-melted in the cupola from the mixed pig, to make a uniform mixture, and then re-melted, and worked in the puddling-furnace.

Mr. Beasley remarked, that he had melted wrought-iron in the cupola, and then worked it in the puddling-furnace, and had found the result to be better than from the ordinary pig-iron alone; but it was not a sufficient advantage to make it worth the extra expense; he had obtained a greater yield.

Mr. Stirling observed there was a process for melting wrought-iron, which was then converted back, by decarbonizing, to a state approaching to steel; it was intended to be used for small articles, such as snuffers, scissors, &c., instead of forging them.

Mr. Adams inquired about the application of the hardened iron to tires. The best scrap tires were found the worst to wear; they laminated more, and, consequently, he did not use them. Those he used were made, he believed, of two blooms, the lower one of scrap or other tough iron, and the upper one from a puddled ball not piled; the wearing surface was, consequently, crystalline iron, hard, not laminated, and was more suitable to resist the rolling and crushing action that the wearing surface of the tire was subject to.

Mr. Stirling replied that he had seen a similar process extensively carried on; the lower part of the tire was made of No. 3 iron, and the wearing surface of No. 2 iron, consisting of two puddled balls hammered thoroughly, then reheated and passed through rolls, and lastly welded to the No. 3 iron for the lower part. For such purposes as the wearing surfaces of wheel-tires and rails, scrap-iron was certainly the worst, from the inequality of the pieces united by weldings, necessarily numerous and irregular; when the wearing and rolling action came into effect, unequal wear and lamination of the surface must be the result.

Mr. T. Fairbairn said the results of the trials he had made of the toughened cast-iron were a near approximation to Mr. Hodgkinson's experiments; but he did not think it would be prudent, or altogether safe for an architect or engineer to reduce the section of a girder to the extent which the relative transverse strength given in the tables would appear to warrant; he would rather retain the large section, and avail himself of the additional security which the use of the toughened iron undoubtedly gave.

Mr. Stirling observed that, to obtain the full increase of strength, would require different trials with different iron, in order to ascertain the best proportion of scrap; but, in the right proportions, from the general results of observations, he believed it might be confidently stated that one-fifth of the weight might be taken from ordinary sections of girders, by using the toughened cast-iron, leaving a greater strength of girder; however, he would much prefer seeing all the strength of the ordinary section left for extra safety. The strengths given in the tables in the paper were chiefly taken from Mr. Hodgkinson, and were the average results of his experiments, showing an increase of transverse strength of 78 per cent.

Mr. R. Williams asked whether, in practice, any difficulty was found to arise in uniting the two qualities of hard and soft wrought-iron?

Mr. Stirling replied, that no difficulty was found in the manufacture, and they were found to be soundly welded together.

Mr. R. Williams observed that, as the hard iron, which melted at a lower temperature than the soft iron, was necessarily the topmost in the pile, when placed in the furnace to be welded, either that would be over-heated at the expense of its quality, or the inner piles would be underheated, and endanger the soundness of the bloom. With regard to the lamination of tires, this was not so much owing to the fact of their being made of piled iron, as to the mode of piling; and, by piling the bars edgewise instead of flatwise, there was little, if any, liability to laminate. Puddled iron could be made hard or soft, at pleasure, according to the management of the process, without the introduction of any alloy into the puddling-furnace.

Mr. Stirling replied, that the hard iron came quite as soon to a welding heat as the other iron, and a most perfect weld resulted.

Mr. M'Connell remarked that, in the manufacture of steel tires, the steel did not lengthen so much as the iron in rolling, and it made a difficulty, in rolling the tires, to make them sound throughout; and he inquired whether any difficulty of that kind was found with the hardened iron for the wearing surface of tires and wheels.

Mr. Stirling replied that, in rails, no separation between the materials had been found; he had not yet had experience in tires. On the Edinburgh and Glasgow railway, on the steep incline, at Cowlairs, Mr. Adie had had rails hardened on this plan laid down for some years, and had found them to last better than steel-covered rails, which had been also tried, and usually wore out in a considerably shorter time; the hardened rails were still going on well, and an additional portion of that line was now being laid with them. In consequence of the first rails manufactured being made too hard, they showed distinctly a tendency to separate, and the failure was valuable as experience; also, they were made more liable to separate, by the hardened piece laid on being round-topped in the pile; 50 or 60 rails, made at the very first works where the plan had been tried, had been broken at different times, for examination, and were found quite sound.

Mr. E. A. Cowper said he had used wrought-iron scrap mixed with cast-iron in the ladle, the melt being rather hotter than usual; it closed the grain of the iron very much, and was found advantageous in casting hydraulic presses, or other castings where a very close grain was required. He had put in as much as 15 per cent. of scrap.

Mr. Stirling observed that he had never found that more than about 5 per cent. could be combined in that manner, and then the mixture must be more or less imperfect, and the metal would be partially chilled.

Mr. Cowper said he had not found any objection from the metal being cooled; it was taken pretty hot, and clean iron-turnings were put into the ladle, and well stirred up, which secured complete mixture and fusion.

Mr. Slaughter inquired, what was the relative cost of toughened cast-iron.

Mr. Stirling replied that, in a girder, if the section were reduced one-fifth, the cost would be cheaper; if the price of cast-iron were very low, the toughened iron would then be proportionately dearer.

Mr. Slaughter said he had tried the toughened iron for a number of locomotive-cylinders, at the recommendation of Mr. Gooch, on the Great Western railway, and found it made very fine, perfect, and sound castings, better than he had ever made before. He intended to continue the use of it, and considered it an excellent material for cylinder castings, and preferable for any purpose for which the strongest and best iron was required. He did not find the iron dearer, but, on the contrary, less expensive than the iron he had previously used for the purpose.

Mr. Stirling explained that the toughened iron might be made from a cheaper iron, such as the Scotch hot-blast, which, at £3 per ton, would be about £3 10*s.* for the cost of the toughened iron, which would then surpass in strength a dearer iron, such as Blaenavon, at £5 or £5 10*s.* per ton; so that, although the increased expense of the process was 10*s.* or 12*s.* per ton, the final cost was less, because a cheaper description of iron could be used, and a greater strength was at the same time obtained, as shown in the table of experiments.

Mr. Slaughter said he had found that the toughened iron was less expensive. That which he used was made from Dundyvan or Calder iron, at £3 or £3 10*s.* per ton, and he found it better, when toughened, than the cold-blast iron which he had previously used, at £5 or £5 10*s.* per ton.

The chairman proposed a vote of thanks to Mr. Stirling, for his valuable and interesting paper, which was passed. He thought that important practical results were likely to follow from such an able investigation, and they were much indebted to Mr. Stirling for bringing it before them; and he trusted that he would continue the course, and favor the institution with the further results.

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Comparative Values of Anthracite and Bituminous Coals for Generating Steam.

The subject of the letter here presented, which we extract from Stuart's great work on the Naval and Mail Steamers of the United States, is one of the most important in steam-engineering; and it may be considered somewhat remarkable that although coming constantly under the observation of engineers, and made the immediate object of expensive experimental inquiry, it should yet be to a great degree complex and obscure. The experiments here recorded, differ, as will be seen, materially in their results from any obtained by the elaborate experimenters on either American or foreign coals, but, we may add, are considered practically correct by several eminent engineers; and although rejected, we think generally, by the scientific world, they may be said to have lately received the endorsement of Yale College, an important point in a labored article by W. A. Norton in Silliman's Journal, being based upon these results. Professor Norton, in treating of the Caloric Engine, adapts as a fixed fact the fraction $\frac{7}{10}$, to show the value of bituminous compared with anthracite, in accordance with General Stuart's conclusions, and is at some labor to reduce the consumption in vessels burning bituminous to a corresponding smaller weight of anthracite. The letter below is addressed by the Engineer-in-Chief of the Navy to the Chairman of the Committee on Naval Affairs, and is supplementary to a report on the same subject in which the time of getting up the steam compared as follows:

Bituminous	70 minutes,
Anthracite	45 "

and the actual evaporative values, pound for pound, compared as follows:

Bituminous	1·000,
Anthracite	1·628.

It is proper to add that the boilers of the pumping engine at the Brooklyn Dry Dock (three drop-flue boilers) on which most of the experiments were made, had been designed especially for the use of bituminous coal.

Sir:—The Senate, by resolution, having called for my reports to the Navy Department, giving the results of several experiments to test the relative value of the anthracite and bituminous coals for generating steam, and referred the same to the Committee on Naval Affairs, I have thought that the results obtained from additional tests and experiments, made in this country and England, would be of service to the committee, and trust that the importance of the subject, both to the interests of the government and of individuals, will be considered a sufficient apology, if any be needed, for the liberty I have taken in addressing you this communication.

It should be remembered that what is required to be known on this subject, is neither the absolute nor relative evaporation by coals under conditions that never occur in practice (as too many experiments are conducted), but the facts to be determined are, the results which can be obtained from them under the ordinary circumstances in which they are used in marine boilers.

With this view I have prepared the following tabular statement, showing the actual evaporation of water effected by bituminous and anthracite coals in the boilers of several naval steamers, and in those of some transatlantic and river steamers plying to and from New York the past few years.

This table, therefore, from being prepared with care from the steam-logs of the different vessels (those of the navy being on file in this office), is of great value; more so, undoubtedly, than if the results had been obtained from a series of special experiments made under circumstances not normal to the practice, which results, therefore, must be extensively modified before they could be received for practical guides.

The table includes all the cases I have been able to obtain at this time, where the data were unexceptionable; it extends, in most instances, over a course of several years' steaming, and the average evaporation thus obtained, although not equal sometimes to the maximum of special experiments, is, in my judgment, more entitled to confidence than any single experiment made with greater critical accuracy, but on too small a scale for trustworthy results.

Of the latter character, I should rank those of W. R. Johnson, Esq., made under the direction of the Navy Department, 1843, in the report of which he states, that "on each sample of coal were made from one to six trials, according to the quantity furnished. The coal consumed in one trial never exceeded 1567 pounds—this being the greatest quantity which the apparatus could receive in the period allotted to each experiment, including the time required for cleaning out the residue, making the necessary adjustments and preparing for a new trial. The total weight of coal consumed in the trials of evaporative power has been nearly sixty-two and a half tons; and the weight used, on an average, nine hundred pounds per trial"—being less, it will be seen, than half a ton per trial, or not three tons for the greatest number of trials made with any one kind of coal, not equal to a two hours' consumption of an ordinary sea-steamer.

These experiments were not only very limited in their extent, but were made with a boiler entirely different in its construction from those of naval and sea-steamers, and not at all adapted for that service, and cannot therefore be compared in value to the following practical tests, deduced from the consumption of hundreds of tons of coals on each steamer named, and in actual service.

Table of Practical Tests of different varieties of Coal.

Name of vessel.	Trade.	Sea-water evaporated from temperature of condenser (100° F.) by 1 lb. of bituminous coal.	Sea-water evaporated from temperature of condenser (100° F.) by 1 lb. of anthracite coal.	REMARKS.
		POUNDS.	POUNDS.	
Michigan,	U. S. Navy,	*5·000		Fresh water.
Mississippi,	" "	†4·760		Sea water.
Spitfire,	" "	†4·870		Sea water.
Engineer,	" "	‡4·681		Sea water.
Alleghany,	" "	†5·000		Sea water.
Iris,	" "	†5·150		Sea water and old flue boilers.
Princeton,	" "	†6·666		Sea water and new boilers.
Princeton,	" "	§5·872		Sea water and new boilers.
Princeton,	" "		7·551	Sea water and new boilers.
Princeton,	" "		6·699	Sea water and old boilers.
McLane,	U. S. Treasury,		7·000	Sea water.
Bibb,	" "		6·000	Sea water.
United States,	Transatlantic Packet,		7·480	Sea water.
Herman,	" "	†4·487		Sea water and old boilers.
Baltic,	" "		8·555	Sea water.
City of Pittsburgh,	" "	†4·930		Sea water.
New World,	Hudson River,		8·022	Sea water.
Commodore,	Long I. Sound,		7·282	Sea water.
Roanoke,	New York and Norfolk,		6·554	Sea water.
		10)51·416	9)65·116	
	Averages, . .	5·142	7·235	

* Pittsburg coal. † Cumberland coal. ‡ Virginia coal. § Scotch coal.

From the averages of the above table, it will be seen that the economical evaporation by the anthracite exceeded that by the bituminous in the proportion of 7·235 to 5·142, or about forty-one per centum of the latter.

In the experiments made on coals by Playfair and De la Beche, by order of the British government, in 1848, I find eleven varieties of Welsh coals having a constitution almost identical with the nine specimens of various Pennsylvania anthracite, experimented on by Johnson, viz.:

	Welsh anthracite.	Pennsylvania anthracite.
Fixed carbon..........................	84·54	88·54
Sulphur..........................	0·79	0·05
Other volatile matter..............	8·40	5·17
Earthy matter, &c.................	6·48	6·51
	100·21	100·27

The average evaporation of water by Welsh anthracite, and by the Pennsylvania anthracite, was as follows:

Fresh water evaporated from the temperature of 212° F., by one pound of coal.

By Welsh anthracite........................9·263 pounds.
By Pennsylvania anthracite.................9·520 "

Thus far there is a very close agreement between the results obtained by the different experimenters from substantially the same coal—that coal being anthracite.

In the experiments of Playfair and De la Beche, above cited, I find three varieties of Welsh bituminous, three varieties of Scotch bituminous, and one variety of English bituminous, having a constitution almost identical with the five specimens of Maryland (Cumberland) bituminous coal experimented on by Johnson.

	Welsh, Scotch, and English bituminous.	Maryland, (Cumberland,) bituminous.
Fixed carbon..........................	75·00	75·05
Sulphur..........................	1·47	——
Other volatile matter..............	14·55	15·45
Earthy matters, &c.................	8·97	9·49
	99·99	99·99

The average evaporation by Welsh, Scotch, and English bituminous and by the Cumberland bituminous, was as follows, viz.:

Fresh water evaporated from a temperature of 212° F., by one pound of coal.

By Welsh, Scotch, and English bituminous...8·02 pounds.
By Maryland (Cumberland) bituminous.......9·93 "

Here is a great discrepancy between the results obtained by the two experimenters on substantially the same coals; Johnson making the Cumberland bituminous better than the British bituminous in the proportion of no less than twenty-four and a half per centum of the latter. Had a similar difference been found in the case of anthracite between the results of the two experiments, it might have been accounted for by a difference of boiler or method of conducting the experiments.

From an investigation of the two kinds of boilers employed, I am of opinion that though in their proportions separately different, yet in the aggregate they were equivalent; an opinion justified also by the equality of results obtained with anthracite.

The results, then, of Johnson's experiments are that Cumberland bituminous exceeds the Pennsylvania anthracite in economical evaporation, four per centum of the latter; while the results from the English experiments, on substantially the same coals, make the economical evaporation of the anthracite to exceed that of the bituminous over twenty-four per centum of the latter.

I would here beg leave to remark that there were several important facts attending the experiments of Professor Johnson, which, rightly understood, would greatly modify his results; and which facts it is absolutely necessary to consider in order to arrive at correct practical information. One of the most important of these is the rapidity of combustion, which is ordinarily measured by the number of pounds of coal consumed per hour per square foot of grate surface, the average quantity of which in marine boilers may safely be taken at fifteen pounds.

In Johnson's experiments, however, the consumption of Cumberland bituminous coal was at the rate of only $7\frac{11}{100}$ pounds, and of anthracite $6\frac{43}{100}$ pounds; an average of less than half the practical rate of consumption.

It is obvious, therefore, that the rapidity of combustion being an important element in determining the evaporative efficiency of different coals, that in any experiments made to ascertain this efficiency for marine boilers, the rapidity of combustion should be about the average of what occurs in actual practice at sea.

Again: the importance of the rate of combustion in effecting the results to be obtained from anthracite or bituminous coals, are well signalized in the following extract from a paper by Chief Engineer Isherwood, United States Navy, published in "Appleton's Mechanics' Magazine," &c., for October, 1851, page 621, viz.:

"In the combustion of bituminous coal, *time* is the important element, and a slow rate of combustion with low velocity of draft is necessary for obtaining high evaporative results, and for the following reasons, viz.: The bituminous portion of the coal is volatalized and separated from the fixed carbon part at a lower temperature than is required for its ignition, that is, than is required for its chemical union with oxygen. In this gaseous state, occupying the furnaces and flues of the boiler, it can only be ignited by being mixed with atmospheric air at a sufficiently high temperature; the element of time is, therefore, doubly important; *first*, to allow the gases to become intimately mixed with the atmospheric air; *second*, to allow them to acquire the necessary high temperature. If now, by means of a powerful draft, the gases, having only the low temperature due to their volatilization, be driven so quickly through the flues and out of the chimney of the boiler as not to allow them time enough to acquire the proper temperature for combustion, and to have the proper mixing with the atmospheric air, a great loss of effect must inevitably follow.

"For the economical combustion, then, of bituminous coal in generating steam, there should be a slow rate of burning, or a small amount consumed per unit of time per unit of surface."

"In the combustion of anthracite coal, however, the above general observations do *not* apply. Considering the principal portions of the anthracite to be fixed carbon, there will of course be no volatilization of bitumen at a lower temperature than what is required for the ignition of the fixed carbon; the coal will consequently remain unchanged until the temperature is sufficiently high for its combustion, that is, for the combustion of its fixed carbon; a forced draft cannot, therefore, carry off the fuel before it is ignited, and in this view velocity of draft is comparatively unimportant. Again, combustion with the anthracite is effected solely by the contact of the air with their solid surfaces; there is therefore no mixing to be done, and consequently no time required to do it in. Here, then, under two important conditions, great velocity of draft, which is highly detrimental to the economical combustion of bituminous, is unimportant in the combustion of anthracite coal."

Taking the above views to be correct, which it is believed they are, it will be perceived that the very *slow* rate of combustion used with the bituminous coal in Johnson's experiments (a rate utterly out of question with marine boilers), was in the *highest degree favorable for the development of the full heating power of the bituminous coal;* now, as this rate of combustion is impracticable in marine engines, a very great correction for inferior results to be obtained by the faster rate of combustion must be made, in order to obtain their *practical value.* With the anthracite, the very slow rate of combustion used was positively a *disadvantage*, as it could not keep the *whole* mass sufficiently high to enable the fixed carbon to take up the oxygen of the air as fast as the latter entered; consequently it exerted, in a considerable degree, a *cooling* power.

Further, it is generally acknowledged that the quantity of *carbon* in coals is at least an index, if not a full measure of their practical heating power. This idea is entertained by Johnson himself, and is announced in his work on coals, published in 1850, pages 118, 123, and 124, viz.:

"The British experimenters continued their analysis of the coals till every sample had been submitted to both proximate and ultimate determination. In the American experiments time was not allowed before the report was demanded, for extending the ultimate analyses to more than one-eighth part of the samples. From such trials as were made, the deductions which appeared to be authorized by a careful comparison between the constituents of the coals and their *evaporative efficiency* was, *that the latter depended upon the total amount of carbon in the coal.* If hydrogen had been, as many European chemists had contended, the more efficient element, weight for weight, then all highly bituminous coals ought to have presented a greater heating power than those of lower bituminousness."

"Both the American and British experiments concur in proving the *reverse of this to be the fact.*"

"This development finally *sets aside the old calculations about the relative heating powers of carbon and of the hydrogen in coals.* By the principle of that calculation, any coal having a high degree of bituminousness ought, in consequence of the large proportion of hydrogen in its bitumen, to possess a much higher heating power than any coal of lower bituminousness. *The reverse of this is true. The higher the bituminousness, or, in other words, the greater the proportion of volatile matter* *a coal contains, the less is its available heating power.* The fact has been pointed out in former publications of the writer, that when solid hydrogen (that being its state in coals) is converted by the effect of heat into gaseous hydrogen, it requires for this change a large amount of heat, as experimentally proved in the manufacture of illuminating gas. The hydrogen thus brought to the gaseous state, assumes the same bulk at a given temperature, say 212°, as it will retain at the same temperature when converted into vapor of water under the atmospheric pressure; and consequently unless we can suppose the capacity for heat of gaseous hydrogen, bulk for bulk, to be greater than that of the vapor of water, we can conceive no reason why it should give out more heat in combining with oxygen than it had taken up in being converted into gas. The British Commissioners refer to this view of the subject, but do not clearly express an opinion of its validity.

"Fortunately their silence is of less importance, as their own experiments furnish abundant proofs of the correctness of the principle. In order more clearly to exhibit the independence of *hydrogen efficiency* in computing heating powers of analyses, we have placed in the above table the per centage of hydrogen found in each sample of coals. From this column the averages are deduced, and a glance will show, that so far as any law or relation is perceptible, the *coals of highest heating powers are those which have the lowest per centage of hydrogen.*" The table above referred to, condensed from Johnson, stands as follows, viz.:

	Hydrogen.	Carbon.	Steam by experiment.	Steam by calculation.
	PER CENT.	PER CENT.	POUNDS.	POUNDS.
Four coals, average............	4·13	74·15	7·78	8·43
Do. do..............	4·90	76·63	8·85	8·87
Do. do..............	4·57	79·67	8·65	8·93
Do. do..............	4·86	81·06	8·89	8·75
Do. do..............	4·17	85·08	9·17	9·25
Do. do..............	4·65	88·12	9·50	9·51
Do. do..............	4·47	88·99	9·75	9·75

"Thus the four coals having a heating power of 7·78, have excess of hydrogen 4·13; the four having heating powers of 9·17, have of oxygen in excess 4·17. It will also be noted that an intermediate class of coals having a heating power of 8·65, has a higher per centage of hydrogen than either of the above, viz., 4·57. This is as we might expect to find it, if the *hydrogen be truly without efficiency in the practical use of coal. Indeed, the hydrogen appears from the practical tests thus far adduced, no more to merit the consideration as an element of evaporative efficiency in coal, than an equal weight of silica, alumina, oxide of iron, or other inert substance found in its earthy residuum or ash.*"

It appears to be difficult to reconcile the foregoing and well-established facts, with the numbers given by Professor Johnson as the results of his experiments on anthracite and Cumberland (bituminous) coals, the former containing $88\frac{54}{100}$ per centum of carbon, and the latter only $75\frac{96}{100}$ per centum, while he makes the latter *four per centum* better than the former, while it should have been, as above demonstrated, the reverse, in the proportion of $88\frac{54}{100}$ to $75\frac{96}{100}$, or eighteen per centum.

The results of the British improvements on substantially the same coals, viz., containing relatively $87\frac{54}{100}$ and 75 per centum of carbon, gave for the former a greater efficiency of twenty-four and a half per centum, making a difference in the results of over twenty-eight per centum.

A large number of experiments and practical tests might be cited to further prove the greater efficiency of anthracite over bituminous coals, in proportion very nearly as the element of carbon was found; but they would swell this paper, now already too extended. I have therefore confined the comparison to a few experiments of admitted correctness, to illustrate the facts, and in conclusion would add, that I agree fully with the views expressed in Professor Johnson's report, "that for the purpose of steam navigation, therefore, the rank most important to be considered (in different coals) is in the order of their evaporative power under given bulks. This is obviously true, since, if other things be equal, the length of a voyage must depend on the amount of evaporative power effected by the fuel which can be stowed in the bunkers of a steamer, always of limited capacity. With this scale of value, however, must be combined the relative freedom from clinker, and the maximum rapidity of action; while the rapidity of ignition is of inferior importance, but may deserve some consideration where short voyages, frequent stoppages, and prompt commencement of action are demanded"—all of which qualities I think have been from practical results found to be more fully combined in the white-ash anthracite of Pennsylvania than any other known coal. I therefore fully concur in the opinion of Professor Johnson, expressed in his work on coals, published in 1850, page 160.

"In conclusion I may observe, that while these analyses demonstrate the high destiny and compactness of this coal (anthracite) fitting it for the purposes of steam navigation, for which these qualities, combined with great heating power, are of primary importance, they also show, that for the various arts and for domestic consumption, its properties are calculated to sustain the high character of the central coal-field of Pennsylvania, for the concentrated and durable heat which it furnishes, and the absence of those ingredients which might interfere with its useful application."

I have the honor to be, Sir, with great respect,
Your obedient servant,
Charles B. Stuart,
Engineer-in-Chief, U. S. N.

Anastatic Printing.

From a paper "On Glynn and Appel's Patent Paper for the prevention of Piracy and Forgery by the Anastatic Process."

BY S. BATESON, ESQ.

As some may be unacquainted with the nature of the Anastatic process itself, and of the abuses of which it is capable in unscrupulous hands, I think it right, in the first place, to give you a short account of its history, nature, and progress. It was invented some eight or nine years ago by Mr. Rudolph Appel, a native of Silesia, who came over to this country. Owing to various circumstances, the Anastatic printing languished for several years, until tardy justice was done to its inventor at the Great Exhibiton in 1851, when a prize medal was awarded him. Since that time it has been becoming more generally known. The term "Anastatic" means rising up, or a reproducing as it were, and very significantly does the name express the result; for by it any number—thousands upon thousands—of reproductions of any printed document may be obtained, each of which is a perfect *fac-simile* of the original, no matter how elaborate the engraving may be, or how intricate the design.

I will now endeavor to describe the actual operation of Anastatic printing. The print of which an Anastatic copy is required is first moistened with very dilute nitric acid (one part of acid to seven of water), and then being placed between bibulous paper, all superabundance of moisture is remove. The acid being an aqueous solution, will not have attached itself to the ink on the paper, printers' ink being of an oily nature; and if the paper thus prepared be placed on a polished sheet of zinc and subjected to pressure, two results follow:—In the first place, the printed portion will leave a set-off or impression on the zinc; and secondly, the nitric acid attached to the non-printed parts of the paper will eat away and corode the zinc, converting the whole, in fact, into a very shallow stereotype. The original being removed (perfectly uninjured), the whole zinc plate should next be smeared with gum-water, which will not stick to the printed or oily part, but will attach itself to every other portion of the plate. A charge of printers' ink being now applied, this in its turn only attaches itself to the set-off obtained from the print. The final process consists in pouring over the plate a solution of phosphorous acid, which etches or corrodes more deeply the non-printed portion of the zinc, and produces a surface to which printers' ink will not attach. The process is now complete, and from such a prepared zinc plate any number of impressions may be struck off.

The use to which this invention may be applied are various. Copies of rare prints may be obtained without the aid of an engraver. Reproductions of books, or of works out of print, may be had without setting up the type; authors may illustrate their own works, and amateur artists may have fac-similes of pen-and-ink sketches at a very inconsiderable expense. To be in accordance with the facts already mentioned, the anastatic process should only be applicable to the copying of the impressions made with printers' ink; any other inks, however, even the most fugitive, may be adapted to this operation, and hence, without some safeguard, the dishonest practice to which the anastatic process might be applied would be numerous. Copies of checks and bank notes may be taken so as to defy scrutiny. In point of fact, bankers have been mistaken again and again when examining notes and checks forged by this process; and as I have now endeavored to impress upon you the laws, I will shortly describe the antidote which is offered by the patent paper invented by Messrs. Glynn & Appel. It is as beautiful from its simplicity as it is efficacious in its operation. It consists merely in impregnating or dyeing the pulp of which the paper is made with an insoluble salt of copper. After a series of experiments, the patentees preferred phosphate of copper to any other salt; and for this purpose, sulphate of copper and phosphate of soda are successively mixed with the pulp, which, of course, produce an insoluble salt, the phosphate of copper. Besides this, a very small portion of a peculiar oily and non-drying soap is introduced, which affords a double protection. Should the forger attempt to submit a note or check printed on the patent paper to the anastatic process, a film of metallic copper separates between the paper and the zinc, not only preventing a set-off, but cements the paper so strongly that the paper must be destroyed—it can only be removed in small pieces. Thus, the forger is punished by the loss of the original, the public protected, and the banker benefited, as it is presumed no forger would apply for the value of the note so unlawfully used. Hitherto, elaborate engraving, beauty of design, and execution by skilful hands have been the sources of protection, and under such conditions a forger must either be a skilful engraver, or employ some person to engrave for him. This fact has generally led to the detection of forgery; but you can easily imagine how justly alarmed bankers will become when they learn that any one who understands what is called chemical, that is to say, lithographic printing, may, with the aid of a zinc plate, a little nitric acid and a press, be able to produce such perfect fac-similes of notes and checks as to pass the scrutiny of the most lynx-eyed of their clerks. You will agree with me that it would be wrong, if not criminal, to publish to the world so dangerous a process to facilitate forgery, unless I were, at the same time, to produce a safeguard which whould absolutely defeat such attempts.

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Theoretical Investigation of the Caloric Engine, Continued.

To the Editor of Appleton's Mechanics' Magazine.

Sir—In the paper communicated by me to your magazine, bearing the title "General Theory of Elastic-fluid Engines," I made the remark (par. 23), "there is another (cause) which operates seriously *against the working power* of the engine, viz.: the development of heat in the reservoir by the compression of air, as it comes from the supply-cylinder. Air at 60° compressed to a tension of 25 lbs., would have its temperature raised to 120° or 130°. Having this temperature as it enters the regenerators, it receives so much the less expansion by the heating apparatus, or requires so much higher temperature to give it the intended expansion."

I was perfectly well aware that the law of Mariotte applied to the expansion and contraction of air, by diminishing or increasing external pressure, was not the *true law:* I used it because it furnished a ready and elegant means of subjecting the Caloric engine to analysis—and because I knew that the results given by this analysis were *far more* favorable to the engine than would be produced by using the true law.

I was not, indeed, aware how much too great those results were. To investigate this point, and apply the true law of expansion and contraction of elastic fluids to the formula for the Caloric engine, is an object which I have had all along in view ever since the publication of that article. Learning, however, that Mr. Ericsson intended to publish some remarks on my first article, I postponed the execution of my purpose until his paper should appear.

I shall now allude to his "observations" on my "calculations." And since he has chosen to enter the lists against me, in preference to others who have written critical articles on his engine (see Prof. Norton's paper in May No. Silliman's Journal, also "The Caloric Engine" in February No. of Franklin Journal), it is to be regretted that he could not have refrained from a sneer at my "analysis of absurdities," and an illiberal smirk at analytical investigations in general, "the symbolical mystification"—"the horror of all practical men"—"a mystification which smatterers invariably inflict upon them."

Making my bow to the complimentary epithet of "smatterer" he has so politely given me, I shall proceed to show that a little more use of "symbolical mystification" would have saved Mr. Ericsson from many important errors.

I will now take up his "objections" in order, and then "to set the subject free from symbolical mystification, the horror of all practical men," &c., I will adopt his own course of reasoning—diagrams and all—and show that Mr. Ericsson's estimate of the power of his engine is utterly erroneous.

Objection 1st. "It is proper to observe that Major Barnard has omitted several important elements in his analysis, which renders the entire calculations erroneous, and the conclusions worthless. The increase of volume of air furnished by the supply-cylinders occasioned by elevation of temperature during compression, is omitted. It will be shown presently that this increase of volume amounts to 173·3 cubic feet for each stroke, exerting a force of 299,462 lbs. raised one foot high during each stroke."

The fact of development of heat was distinctly alluded to in the words already quoted from my paper, and the remark that its effect was *detrimental* to the working power of the engine. Mr. Ericsson evidently imagines, from the words I have quoted, that it is *favorable* to him, and describes it as causing an "increased volume of air furnished by the supply-cylinders, and exerting a force of 299,462 lbs."

The volume of air furnished *to the reservoir*, is in *fact* greater than it otherwise would be, in consequence of this developed heat; but not one particle greater when it has reached the *working cylinders*, from the simple fact that having already been partially heated, it receives *so much less expansion by the heating apparatus.* The sole effect of this development of the heat is to increase the *resistance of the supply-*piston, without aiding the power of the working piston in the slightest degree. Thus if my "calculations" were erroneous, they were so in a manner recognized and distinctly stated by me; and if my "conclusions" were at all justified by the imperfect theory from which they were deduced, they are not entirely "worthless," but will be exhibited in a still stronger light when the *true* theory is applied to the caloric engine.

Objection 2d. "The rate of speed, 120 feet per minute, assigned to the piston, is wholly gratuitous. Quick motion is a leading feature in the caloric engine, and in no instance has it yet been found that the heating of the air has not been performed with sufficient rapidity. Major Barnard, in questioning the capacity of the furnaces in this respect, appears to overlook the fact that the regenerators are the principal heaters."

I am aware that the speed of the piston is entirely a *practical* matter. I have offered no theory with regard to it. I have taken 10 revolutions per minute as a basis of calculation, because that was something more than the Ericsson engines usually performed. Every engine properly constructed is adapted to a certain rate of motion, which intended rate is indeed an element in arranging the whole machine. If the machine is inharmoniously arranged—is attached to a resistance which it is incapable of overcoming at the intended speed, the fact is at once indicated by an accumulation of *pressure*, indicating that the machine is endeavoring to perform a task too great for it. Thus, if a 300 horse-power engine, intended to make 15 or 20 revolutions per minute, were attached to the cranks of the steamer Atlantic, it probably could not make half that number; but if the furnaces were kept in full operation, steam and pressure would accumulate indefinitely. Under these circumstances, the pressure on the piston multiplied by the rate of motion, would not form a proper means of determining the power of the engine.

Now the Ericsson's engines are certainly inharmoniously arranged. Engines of at most 5 or 600 horse-power are attached to the cranks of a 2200 ton ship; but there is no accumulation of pressure; on the contrary, the pressure has never been brought up to its intended standard, and although "quick motion is a leading feature in the caloric engine," the engines of the Ericsson have never been found to "fret in the traces." They submit with a very good grace to a very *slow rate of motion.*

When Mr. Ericsson will put an engine into the caloric ship capable of developing a static pressure equal to the resistance on the paddles of a 2200 ton steamer moving 12 knots an hour, then I will leave the question of quick motion to be effected by suitable heating apparatus—if it can.

I will conclude what I have to say on this subject by stating, that (after the maximum working pressure that can be exerted by the Ericsson's engines with the intended tension of 12 lbs. is known), it will be conceded that Mr. Ericsson's assumption of 200 feet per minute speed of piston is not only "gratuitous,"* but unwarranted by any proof or probability.

Objection 3d. "The effect of the momentum of the heavy pistons in counteracting irregularity of motion, is entirely overlooked. This latter oversight, and the assumed necessity of carrying the active force to the termination of the stroke, has induced Major Barnard gravely to consider the propriety of employing working and supply cylinders of equal magnitude."

I have not "assumed the necessity of conveying the *active force* to the termination of the stroke," but I have assumed the necessity of not permitting an immense negative force to accumulate. I shall show hereafter, that if 12 lbs. pressure is ever obtained in these engines, a negative force at end of stroke will be developed far beyond the estimate of Mr. Ericsson.

Mr. Ericsson has consumed most of his space in combating my "absurd proposition" to make the supply-cylinder equal to the working-cylinder.

I do not know that I ever proposed, as a general rule, to do this. In par. 8, I remarked, that "for a *single engine worked in such a way* that the resistance of *the supply-cylinder* shall not exceed the *final pressure of the working-cylinder*, the maximum effect will be attained by making *m* nearly equal to 1, or the supply *nearly equal to the working cylinder.*" This was for a particular case, and I did not say that case was the best arrangement.

Again, in par. 19, I said that "by using a supply-cylinder of $\frac{9}{16}$, it *would appear* that these figures" (denoting the power of the engines) "*might be increased.*"

I spoke in a guarded manner in both cases—I did NOT recommend; and I will now state† that my conclusions were based upon the idea that an indefinite amount of pressure might be used—not confining myself to the 12 lbs. that Mr. Ericsson takes as his constant standard. With a 12 lbs. pressure, I believe $\frac{3}{4}$ (as he has it) a good proportion for the supply-cylinder.‡

I will now examine Mr. Ericsson's estimate of the pressure of his engine as presented "in a diagram resting upon a simple geometrical basis."

But first I must ask him to favor us with a "geometrical solution" of the fact, that air compressed to a tension of 27 lbs. has 60° of temperature developed, and that this increase of temperature will swell the volume "fully one-eighth." I have nothing but his word for it, and the matter is too important to rest on the assertion of any one. Let us have the "geometrical solution which all can understand."

This assumption of 60° increased temperature is not established by him, by either argument or experimental facts; and it is not in conformity with the laws of developed heat established by others, as I shall presently show.

The calculation given by Mr. Ericsson of the power of his engine, is so full of errors from beginning to end—exhibits so little knowledge of the true laws of the contraction and expansion of air, as influenced by either heat or pressure, that it is almost an invidious task to attempt to criticise it.

Surely when he attempts to hold up "symbolical mystifiers" to the amusement of "practical men," he should have been sure that he understood the fundamental laws of the subject he was discussing.

He begins by asserting that air compressed to a tension of 27 lbs. will have its temperature increased 60°; while, in point of fact, for the mean temperature of the atmosphere, the increase will be 80°.

He next asserts that an accession of 60° heat will increase the volume of air "fully one-eighth;" which is only true when the *original temperature* of the air heated is considerably below 32°, whereas, in general, it should be taken at the mean temperature of the atmosphere, or 60°.

He next asserts, that "an elevation of temperature of 480°" will swell 7·50 volumes of air (and that without regard to its actual temperature before receiving this accession, now elevated to 120°) to 15 volumes—or in other words, double it.

There is such a complication of errors in all this, that it is hard to point them out. The number of degrees here mentioned, as required to *double* a given volume of air, is, in the first place, incorrect. The recent and elaborate experiments of Regnault have proved that not 480°, but 491°, are necessary.

But this is only from an initial temperature of 32°. Taking a volume of air at any higher temperature, the number of degrees required to double it will be 491+ as many degrees as the initial temperature is above 32°.

Thus for the air Mr. Ericsson is treating of, whose temperature is, according to his estimate, already elevated to 120°, the number of degrees required to double it will be 491 + 88°, or 579°.

Having, however, assumed 480° as necessary to double the volume, he winds up his calculations by an amusing specimen of the rule of three,—If 480° will swell 7·50 to 15 volumes, *then* 432° are necessary to swell 7·50 to 13·50 volumes, forgetting that the number of degrees required are proportional not to the *total volumes*, but to the *increments of volume*.

An increment of 7·50 volumes is required to double 7·50 volumes, and an increment of 6 volumes to swell 7·50 to 13·50 volumes. The proportion should be, then, as 7·50 : 6 : : 480 : 384° instead of 432°, as he makes it, thus committing an error against himself which partially neutralizes the errors he had before committed in his own favor.

It has been necessary thus to point out, step by step, the tissue of errors contained in Mr. Ericsson's computation, to show that that computation is utterly unreliable, and that he is unable to form any correct idea of the theoretical power of his own engine.

I will now illustrate by diagram what the working pressure really is with regard to Mr. Ericsson's standard of 12 lbs. pressure.

But it is unfortunate that we cannot altogether dispense with "symbolical mystifications." "Practical men" who have such a horror of it, find its results very useful. It is necessary to know the law of development of heat, by compression, and on this point I cannot take Mr. Ericsson's "ipse dixit."

I must refer to another "symbolical mystifier, and one to whom Mr. Ericsson will scarcely apply the epithet of "smatterer"—Mr. Poisson.

Poisson's formulæ are as follows:

$$(1)\ p' = p\left(\frac{\delta'}{\delta}\right)^{1·384}$$

$$(2)\ \theta' = (491° + \theta)\left(\frac{\delta'}{\delta}\right)^{0·384} - 491°.$$

In which p and δ, in formula (1), represent the pressure and corresponding density of the air at any given temperature, and p' and δ' any other corresponding pressure and density produced by compression or expansion (the absolute amount of heat remaining unchanged). In the 2d formula, θ is the temperature in degrees above 32° of the air whose pressure is p and density δ, and θ' is the temperature

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* The example of trial engines working without resistance (for none is mentioned) are of no value. Who ever questioned that with nothing but friction to overcome any amount of speed could be obtained?—were not this the case, the caloric engine would be almost destitute of *all* motive power.

† And I will add, that the theory, in these cases, founded on Mariotte's law, does not hold good when the true law of volume is applied.

‡ In another place Mr. Ericsson takes up the subject again, and says, "In regard to the startling proposition of Major Barnard to employ cylinders of equal magnitude, its absurdity will be made manifest merely by estimating the power which will be wasted in turning adrift the air from the working cylinder at a pressure of 12 lbs. after that pressure had been obtained at the expenditure of force and fuel."

I have no objection to make to his calculations, though as regards the absolute amount of power lost, it is quite ERRONEOUS; I have before said, that the use of equal sized cylinders, was in a certain case alluded to—*not* recommended, and that the relative amount of fuel consumed, formed *no part of my investigation*. It was necessary to find first, whether *by any possible arrangement*, power enough could be developed for practical purposes. The amount of fuel used is the secondary consideration to that.

(also in degrees above 32°) after being compressed or expanded to the pressure and density p' and δ'.*

Assuming the mean temperature of the air at 60°, and the pressure or tension at 15 lbs., and calling $\delta = 1$, we obtain the density of air suddenly compressed to 27 lbs. tension, thus—

$$27 = 15\,(\delta')^{1\cdot324}$$

Whence $\delta' = \left(\frac{27}{15}\right)^{\frac{1}{1\cdot324}} = 1\cdot5586$, that is, the density becomes increased in the ratio 1 : 1·5586.

To determine the temperature developed,

$$\theta' = (491^\circ + 28^\circ)\left(\frac{\delta'}{\delta}\right)^{0\cdot324} - 491^\circ =$$

$$= (519^\circ)\,(1\cdot5586)^{0\cdot324} - 491^\circ = 108^\circ,$$

or 108° above 32°, or 140° Fah. The *increase* of temperature then by this compression is 140° — 60°, or 80° instead of 60°, as given by Mr. Ericsson.

The air acquiring its tension of 27 lbs. at a density of 1·5586, it will then commence entering the reservoir, and the portion of the stroke during which the supply piston acts against its full resistance of 12 lbs., is denoted by $\frac{1}{1\cdot5586} = \cdot641$. This gives the means of determining the resistance of the supply piston. To know the force exerted on the working piston, it is necessary to fix the degree of temperature used.†

In the "notes on the Ericsson," the temperature of (Appletons' Journal, Feb. No.) the working cylinder above atmosphere is given at 380° (or total temperature at 440°), and I assumed this as the basis of my calculations in my former paper: as Mr. Ericsson has made no "objection" (in a paper purposely prepared to set forth his objections to my calculations), I shall still assume it as the highest practical temperature he can carry.‡

Therefore, air at 140° carried up by the heating apparatus to 440°, or receiving 300° additional of heat, will be expanded in the ratio of $1 : 1 + \frac{300}{599}$, or 1 to 1·5. It will then fill a portion of the working cylinder, represented by $\frac{2}{3} \times \cdot641 \times 1\cdot5$, or ·641.

Thus the cut-off must be, not at $\frac{2}{3}$, but at ·641, or a little less than $\frac{2}{3}$ the stroke.

But there is another point of difference between Mr. Ericsson and myself, which must yet be settled before the true mean pressure in the working cylinder can be determined. He has commenced his "objections" to my theory by objecting to Mariotte's law, and I have admitted his objection. But he says, "It should here be stated, that while the law of Mariotte is not directly applicable to the determination of the force after expansion in the steam-engine, on account of the fall of temperature, yet, in the case of the working cylinder of the caloric engine, that law is directly applicable, on account of the accession of temperature from the heater after closing the cut-off valve." Now *I* object most strenuously to the application of the law of Mariotte in this case; and I will show that the accession of temperature from the heater, demanded to maintain that law, is entirely beyond the power of his heaters to supply; so much so that Poisson's formula may still be used with but slight error.

It is easy to determine mathematically what accession of temperature is required.

The temperature of working cylinder at cut-off is 440°—tension 27 lbs.—cut-off at ·641; the air therefore expands to the end of the stroke to a volume represented by $\frac{1}{\cdot641}$. Calling t' the final tension, Poisson's formula gives

$$t' = 27\,(\cdot641)^{1\cdot324} = 14\cdot985, \text{ or say 15 lbs.}$$

or becomes just equal to the tension of the external atmosphere.

The fall of the temperature will be determined by the formula

$$\theta' = (491^\circ + 408^\circ)\,(\cdot641)^{0\cdot324} - 491^\circ = 287^\circ \text{ above } 32^\circ,$$

or to a temperature of 319° Fah., now 440° — 319° = 121°.

That is to say, the temperature falls by expansion 121°, and this during $\frac{1}{3}$ of the stroke, occupying less than three seconds (or if we adopt *his* speed of piston, 200 feet per minute, less than *two* seconds). The air, during this time, is motionless, except the motion of expansion: *convection* is the only means of its acquiring accession of temperature.

It is utterly impossible that it should receive a tenth part of this required accession in the required time.§

I shall therefore reject Mariotte's law and apply Poisson's formula to the expansion in the working cylinder.

I have just shown that the pressure ran down at end of stroke, from 27 to 15 lbs., as determined by this formula; and I have now the means of illustrating by diagram, the power of his engine working at 12 lbs. pressure in reservoir.

The rectangle *a b c d* represents the magnitude of the working cylinder, and *e f g h* that of the supply cylinder (dimensions and proportions of the diagram same as Mr. Erisson's). *k'* at ·641 of 6 feet from *c*, is the point of cut-off, thence the pressure runs down to 15 lbs. (or nothing above atmosphere) at termination of stroke at *b*.

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[*] The formulæ given by Poisson, are (substituting degrees of Fah. for centigrade, and correcting for the error of old coefficient of expansion),

$$p'/p = \left(\frac{\delta'}{\delta}\right)^{r}$$

and

$$\theta' = (491^\circ + \theta)\left(\frac{\delta'}{\delta}\right)^{r-1} - 491^\circ.$$

In which r is the ratio of *capacities for heat* of air confined to an invariable volume, and allowed to expand under the constant pressure. It can only be determined experimentally, and is given by Poisson from his own experiments at 1·3482 for atmospheric air; by the experiments of Gay-Lussac and Welter at 1·3748, and from the experiments of Dulong at 1·421 for *air perfectly dry*. The lowest of these figures appeared to me to give rather high results, and their difference showed that none were strictly correct; hence I tested the formula (2) by a comparison with a series of experimental observations (said to be accurate by Professor Smith, Astronomer Royal of Scotland) by Mr. Petrie, of the actual amount of temperature developed by various degrees of compression down to one-tenth, and expansion to 1000 times the original volume. By these means I fixed the value of r at 1·324; and thus determined, the formula coincides with the actual experiments through this vast range of densities with great accuracy.

For any change of density from a compression to one-tenth to an expansion to 100 volumes, the temperature given by the formula will always be within 3° or 4° of the truth.

[†] It is worth while to inquire what temperature would be required to make the volume furnished by the supply cylinder (at density of 1·5586) fill the working cylinder with cut-off at $\frac{2}{3}$ as fixed by Mr. Ericsson, and thus produce his estimate power. The expansion required will be as $\frac{2}{3} \times \cdot641$ is to $\frac{3}{4}$, or as ·427 : ·75, or $1\frac{3}{4}$ to a small fraction.

The coefficient of expansion for air at 140° is $\frac{1}{491 + 108} = \frac{1}{599}$; 599° *additional* are therefore required to double, and

$$\text{as } 1 : \cdot75 :: 599 : 449.$$

Thus 449 additional degrees, or a total temperature of 449 + 140, say 589° Fah., is requisite, entirely beyond practical limits of heat; near the low red-heat of iron, and the melting points of lead and zinc, showing that his estimate of power is entirely erroneous; but his calculation is otherwise so full of errors, as to be, in every respect, unreliable.

[‡] It does not appear from Mr. Ericsson's account of his small engine (see Appletons' Journal, Feb. No.), or from the actual performance of the caloric ships, that over 380° above the temperature of the external heat, has ever been carried in the working cylinder.

In his calculation of heat required to fulfil his estimate of power, he has expressed himself so vaguely, that it is not easy to understand what idea he intends to convey.

He finds an "accession" of temperature of 432° necessary: but the air has already been heated (according to him) to 120°.

Does he mean then that he expects to carry (432° + 120°), or 552° in his working cylinder? For this is the necessary result of his reasoning.

I am aware that efforts have been made, in France, to use air at a very high temperature, but it is not known that they have been successful, and I am quite certain that it cannot be so used in the Ericsson engines.

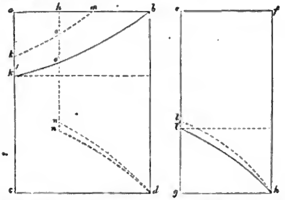
Mr. Ericsson has "repeatedly stated" and "announced to the government," that "the yielding of the wrought-iron heaters has prevented full pressure being carried."

Now is it possible that neither he nor his machinists knew how to make a wrought-iron cylinder bottom that would stand, not 12, but only 8 lbs. pressure? (For 8 lbs. is the highest pressure said to have been carried.)

If the above supposition is not probable, then we must suppose the wrought-iron heaters to have been already *burnt out*, as is quite probable. And this must prevent carrying any temperature approaching to redness, either in the wrought or cast iron bottoms. The great and unequal expansion of cast-iron (for wrought has been tried and abandoned), its liability to cracks in these enormous surfaces, must confine the temperature of the heaters to narrow limits.

[§] Mr. Ericsson only expected his heater to furnish 30° of heat to the air during the first $\frac{2}{3}$ of the stroke, as the regenerators perform the rest of the task; yet he now expects the same heaters to furnish, under these unfavorable circumstances, 120° in two seconds.

In the supply cylinder *l'*, at ·641 of 6 feet from *e*, is the point at which the air acquires its full tension of 27 lbs. Hence the figures *k' b d c* and *e f h l'* exhibit the relative power and resistance of the working and supply piston.



Super-posing one on the other, the differential area *c d n' o' k' minus* the area *b h o'* represents the effective working power of the engine, and the area *b h o'* represents the exact amount of *counteracting* force at the end of the stroke.

The area *k m b d c* represents the power of the working piston, as given by Mr. Ericsson, and *e f h l* the resistance of the supply piston. The difference between us and the error of his estimate,* is represented by the area *k m b k'* + the small area *n d n'*.

To avoid complication (the logarithmic formula for expansion cannot be used), I will consider *h l'* and *b k* as straight lines—(the error is in favor of the engine.)

The mean pressure on working piston will be represented by

$[(\cdot641 \times 27) + \cdot359 \times \frac{1}{2}(27 + 15) - 15)] \times 22\cdot300 = 219239$ lbs.

The mean resistance of the supply piston by

$[(\cdot641 \times 27) + \cdot359 \times \frac{1}{2}(27 + 15) - 15)] \times 14866 = 146065$ lbs.

making the total effective mean pressure 73·174 lbs., giving (allowing as before 10 revolutions) 266 *aggregate* horse-power for each engine.

Mr. Ericsson finds by his diagram an effective pressure of 108·385 lbs., which I have shown to be too great by 35·211 lbs., or near 50 per cent. on the *real pressure.* At the termination of the stroke the working pressure runs down to nothing, and the resisting pressure on supply piston is 12 lbs. The negative pressure at this point is 178,400 lbs., and as a mean 89,200 for the last ⅓ of the stroke (instead of 32,335 lbs., as given by Mr. Ericsson).

If any will take the trouble to investigate the effects produced by the counteracting pressure just given, they will find that not only is the momentum of the piston unable to overcome it, but that it will consume nearly all the power of the mate-engine in the latter part of its stroke, leaving little but their momentum to drive the wheels. This counteracting pressure, then, as given above, has about reached its extreme limit, showing that more than 12 lbs. *cannot* be used, thus establishing a practical limit to the power of the engine in that way; and indeed it is doubtful whether *as much* as 12 lbs. pressure *can be* carried, in consequence of this counteracting force.

Before closing with Mr. Ericsson's objections, I must make a brief allusion to his last paragraph. And first, as to the "improper haste with which the results of the trials of the caloric ship have been rendered and calculations made in disparagement of the new engine."

Caloric engines are not a new thing; they are as old as the steam-engine. The engines of Mr. Ericsson's invention were said to have been built and tried successfully before the caloric ship was built: so successfully that no mere experiment could be implied by constructing a ship of 2000 tons and upwards with every thing complete for the accommodation of passengers. There was a *certainty* of success implied by all this.

The trial trips were made and the government appealed to, to appropriate large sums for the construction of vessels of war to be fitted with these engines. At the same time every fact connected with the real performance of the "Ericsson" which could be, has been suppressed. "Practical men"—engineers, have been rigorously excluded from all the trial trips, and the greatest mystery has been preserved in relation to the performance of the engines.

Simple facts upon which an estimate of the real power of the engines could be made, have been withheld; and when at last Mr. Ericsson condescends to put down a "symbolical mystifier," and to make as clear as the light of day *to all* by a "geometrical solution" the power of his engines, his statements are so meager, and his computations so erroneous, as to make it evident that a little more knowledge, somewhere, would be desirable before any true estimate can be formed of their real power and economy.

Such facts as have really come to light, make rather a poor show for the pompous phraseology with which the success of the trial trips was first announced.

It was natural that engineers should seek to know what the real facts of the case were, and equally so to investigate the real working power of the engines, after their manner of construction had been fully described and certain facts made known. I, for one, took up the subject with no unfavorable impressions—rather the reverse; and though Mr. Ericsson sneers at and condemns my "analytical absurdities," I adopted this method of investigation because I was not willing to stake *my* opinion upon the particular dimensions of his engine, or the particular facts set forth by his trial trips. I discussed the subject in the most general manner, and have left out of consideration entirely the question of economy of fuel, conceding to Mr. Ericsson any degree he chooses to assume, if he can but get caloric engines into a ship of power enough to propel her with any reasonable speed.

But in relation to this subject, Mr. Ericsson makes assertions from which I must beg leave, most emphatically, to withhold my assent.

He says, "In the steam-engine, when reduced pressure is carried, the consumption of fuel is reduced in an equal proportion—not so in the caloric engine. The principal source of heat being the regenerator, neither speed nor pressure exercises any material influence on the quantity of fuel consumed. I must here (he goes on to say) emphatically record the fact, that the quantity of fuel consumed in turning the wheels at the dock at 4½ turns per minute, differed very little from the quantity consumed under way, making 9 turns per minute." This fact may be true and prove little: we have no means of judging of the *real power expended* in turning her wheels 4½ times at the dock; under such circumstances the *number of turns* alone will not measure the power.

And I most emphatically assert, that the regenerators, instead of being the *principal* source of heat, are not a *source* of heat at all. The furnaces are alone the *sole source of heat.* And that the heat *consumed* in the caloric engine will bear the same proportion to the work done as in the steam-engine.

While I say this, I admit fully the important office performed by the regenerators; though I view the matter in a somewhat different light from Mr. Ericsson.

It is now pretty well understood that heat, like every other motive agent, has its "mechanical equivalent," just as the falling of a cubic foot of water through a certain height has its equivalent or measure.

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* There is but one qualification to make to this statement, and that regards the degree of heat carried in the working cylinder; I have assumed it at 440°. If a higher temperature can be carried, it will give a higher power. The reasons why I have assumed it, have been already given: viz., that it is the highest temperature *known to have been* obtained, and because Captain Ericsson has not objected to my previous calculations, based upon it.

For authorities upon which the above estimate is founded, I refer to the recent experiments of Regnault for determining the true coefficient of expansion by heat—vide Annales de Chimie et de Physique (and republished in Franklin Journal); to the investigation of Poisson for establishing the law of volumes as effected by external pressure alone (vide Poisson, M canique, p. 687, vol. 2); and the experiments of Mr. Petrie on heat developed by compression, &c., a tabular statement of results of which may be found in Weale's Series, "Steam and Locomotion," p. 77.

The best constructed machines using water have not developed, by a considerable per centage, the full equivalent of this agent; and those using heat, as the steam-engine, are still further off from reaching the mechanical equivalent of heat. This equivalent may be indefinitely approached by increased perfection of machinery, but it can never be fully attained, much less surpassed.

The nearness of approach will depend upon the intermediate agent used, and the manner in which it is used. If air is the agent, and it is used by simply heating, and then discharging into the atmosphere, like steam in a high-pressure engine, the result produced would be so far from what was due to the heat consumed, as to put such an engine at once out of the question. And this owing to the fact, that from the physical character of the agent, the amount of heat necessary to expand air to a limited degree, is enormously out of proportion to the degree of power developed. The air thus discharged would have a temperature far above that of the surrounding atmosphere; and for the same reason (as expressed in one of Mr. Ericsson's arguments) that we cannot set air or steam adrift having a *pressure* far above the surrounding atmosphere, we can neither set it adrift having a *temperature* so elevated, without a great loss of motive power. And when this state of things exists, it is in the *nature of things* that by suitable contrivances this excess either of pressure or heat may be saved. This is what, to a certain extent, the regenerators do; they take back heat (not which has once performed its work, *to make it do it over again*, for this is contrary to the nature of things, and can never be done), but which has not yet done its work at all.*

The reported results indicate that by use of these regenerators, the caloric engine is brought into favorable comparison with the steam-engine, so far as consumption of fuel is concerned. This is a point I am willing to concede without argument. But it would be quite as proper to call the receiving reservoir of the Croton aqueduct (which holds water enough to supply New York for a few days, though its supply was cut off) the principal source of the Croton water, as to call the regenerator the principal source of heat in the caloric engine. No contrivance ever yet or that ever will be made, will make a particle of heat *do its work over again*, any more than they will make the bucket-full of water discharged from the water-wheel, ascend to the top of the dam and do *its* work over again. When the caloric engine is working in its normal condition, the fuel consumed, as in the steam-engine, must be directly proportional to the work done.†

I have done with Mr. Ericsson's objections, and will now make some estimate of the amount to be taken off the aggregate working pressure of his engine for leakage, friction, &c.

I have stated the aggregate pressure of each engine of the caloric ship working with 12 lbs. (Mr. Ericsson's standard) of pressure, at 73,174 lbs. I shall consider no other sources of loss than leakage and friction, though it is evident that a considerable differential force is requisite to pass the air through the valves and regenerators.

First, leakage. It is vain to attempt to fix this with any precision but it is easy to determine how much a certain assumed quantity will effect the power of the engine; and to furnish something definite to base an estimate upon, I shall calculate the leakage on the trial trip, from such data as are given.

A pressure of 8 lbs. was said to have been maintained; and those who observed closely, estimated the cut-off to have been put on at $\frac{2}{3}$ the stroke. A similar calculation to that already made for a 12 lbs. pressure will fix the working pressure for 8 lbs. at 55,865 lbs., and the cut-off at $\frac{3}{4}$ the stroke within a trifling fraction. But it, as before said, was estimated to be at $\frac{2}{3}$ instead of three-fourths the stroke.

If all the figures given were strictly correct, the difference between the theoretical and actual place of the cut-off would be due to leakage, which will be the difference between $\frac{2}{3}$ and $\frac{3}{4}$ as compared with $\frac{3}{4}$—or $\frac{1}{9}$.* This appears to be an ample, yet not an extravagant allowance for the large amount of leakage which was said to occur on the trial trip.

Calculating the working pressure—all other elements the same, with a $\frac{2}{3}$ instead of a $\frac{3}{4}$ cut-off, it gives a working pressure of 40,255 lbs., or a falling off of 38 per cent.† from the aggregate; and due to a $\frac{1}{9}$th leakage.

If we apply this same $\frac{1}{9}$ leakage to a 12 lb. pressure, it will fix the cut-off at ·57 instead of ·641, and the working pressure will be reduced to 43,520 lbs. But I will not insist upon so large an amount of leakage as $\frac{1}{9}$‡ (which I do not pretend to have determined from proper data), but will allow it to be, in well-made engines, but half of this, or $\frac{1}{18}$, which will be conceded to be, I think, quite within the truth.

A leakage of $\frac{1}{18}$ fixes the cut-off at ·605, and reduces the working pressure to 63,332 lbs., or 13 per cent. off.

Mr. Ericsson himself allows $\frac{1}{2}$ lb. pressure to overcome friction (which is probably near the truth), and this takes off 11,150 lbs. more from the above, giving 52,182 lbs. for the effective working pressure of each engine, or at ten revolutions, 158 horse-power, or 316 for the two, working with their maximum pressure, and in their best condition.§ From this there should still be deducted the power necessary to pass the air through the regenerators and valves, and loss from clearance, which I have no means of estimating, but which is by no means insignificant.

This I believe to be a fair estimate of the *maximum* performance

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* If a volume of air should be heated, and then permitted to expand until its temperature *had sunk down to its initial temperature*, and all its expansive force were husbanded, it would be equal to the supposed mechanical equivalent (see Joule's experiments, London and Edg. Phil. Magazine); but then it is evident that regenerators could abstract nothing from it, and likewise, that heat would be consumed.

In practice the expansive force of air cannot be made use of below the atmospheric pressure, hence the necessity of discharging the air at a high temperature; and the incidental part played by the regenerator.

It has been asked "if the regenerators could abstract *all* the added heat, what would be the result?" A perpetual motion of course; but the supposition is *simply impossible*. By the simple act of abstraction they become *themselves heated*, and cannot reduce the heated air lower than they are themselves, or in other words, down to its initial temperature; moreover, the air after expansion in the working cylinder has become more rare[1] than it was in the atmosphere, and if the regenerators could reduce it down to *its initial temperature in reservoir*, there would still be an amount of heat carried off owing to the rarified state of the air, and this amount thus carried off, would be exactly the *mechanical equivalent of the work performed*.

This illustration proves that the regenerators can only abstract heat *over and above that due to the mechanical equivalent of the work performed*. And since they can never perfectly perform this last task, we cannot hope, by their means, to make heat equal, much less surpass, its mechanical equivalent of work.

† The furnaces being the sole source of heat, a certain *time* is required for them to do their work, and it is by no means to be assumed that they will perform it at *any* required rate of speed.

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[1] This is not *necessarily* the case, for the supply might be equal to the working cylinder, in which case the air would be discharged of the same density as received, but if the regenerators could cool the affluent currents of air down to the lowest temperature of the inflowing air, they yet *could not abstract one single particle of heat that had done its equivalent of work*.

* This leakage has been calculated both in the Franklin Journal and Silliman's Journal at about 20 per cent.; but as the writers have assumed the doubling in volume of the air in passing the heaters (an impracticable thing), their estimate is extravagantly high. But the small amount adopted hereafter by me (one-eighteenth or about 6 per cent.), is unquestionably quite below the truth.

† The diminution of power seems greatly disproportionate to the amount (11 per cent.) of leakage, but it must be recollected that the working pressure is a differential one, and that the leakage comes off from the positive term (affecting *it* merely in direct proportion to its amount), while the negative term (the resistance of the supply-cylinder) remains undiminished.

We were told by Mr. Ericsson that a hole one-half inch in diameter was permitted to remain open in the reservoir of the trial engine, and that the pressure was not "sensibly" affected, "so abundant was the supply of air." On the other hand, we were told that the caloric ship's engines could not work up to her intended pressure on account of *leakage*. Again, we are told that it requires no time to heat the air, because the regenerators *are the principal source of heat;* and in the next breath that the intended pressure cannot be obtained, because the cylinder bottoms could not bear the heat and pressure. What confidence is to be placed in such incoherent statements? The above illustration of the effects of leakage will show "practical men" that the *unavoidable leakage* is an enormous per centage off the effective pressure.

‡ A large leakage is unavoidable, from the immense size of the cylinders used, and from the unequal temperature of the working-cylinder. The upper end of that cylinder is kept comparatively cool, while the lower portion, where it terminates its stroke, must partake of the temperature of the heated air. From the known expansion of iron, the diameter of a 14 feet cylinder would expand, heated from 60° to 460°, very near $\frac{4}{10}$ inch. It is impossible to make any packing work tight under the circumstances. In addition to this, there is the leakage of valves and joints, &c.

§ If the aggregate horse-power alone is considered, as deduced from the aggregate pressure, 73,174 lbs., the caloric ship requires more than three times as much to put her on a par with the Collins steamers, using the aggregate horse-power of these as the standard of comparison.

that can be expected from the Ericsson engines; and with this amount of power it is sheer folly to talk of applying the caloric engine to ocean navigation, when to get this, insignificant as it is, four single acting cylinders of enormous dimensions are necessary, with an equal number of almost equally enormous supply-cylinders; the whole weighing nearly as much, and occupying as much space as the engines of the Collins steamers, boilers, coal-bunkers and all.

I will close this paper by giving an analytical expression for the working pressure for the caloric engine, under the true law for expansion and contraction, for the benefit of those who are not horrified by "symbolical mystification."

I will premise by saying that the recent experiments of Regnault and others have shown that the old coefficient of expansion ($\frac{1}{480}$) per degree Fah. was too great, and have established it at $\frac{1}{491}$, and have likewise shown that within limits of pressure varying from $\frac{2}{3}$ to $3\frac{1}{2}$ atmospheres, and temperatures from 32° to 600° Fah., this coefficient was almost invariable.*

For the caloric engine, therefore, $\frac{1}{491}$ may be assumed as the invariable coefficient of expansion, for all densities and all temperatures used.

Call the area of working piston - - - - -	a
The ratio of the supply to the working cylinder, -	m
Length of stroke, - - - - - - -	1
do. do. up to cut-off, - - - - -	x
Pressure of the atmosphere, supposed to be at 60° Fah., - - - - - - - - -	15 lbs.
Density do do	1
do of air in working-cylinder before cut-off, -	d
do do. in reservoir, - - - - - -	d'
Mean temperature of the atmosphere, - - -	60°
Temperature in working-cylinder, before expansion, (in degrees above 60°), - - - -	τ
Tension or pressure of air in reservoir (and in working cylinder before cut-off), - - -	t
do. do. at end of stroke,	t'
Mean effective pressure on working piston, - -	P'
do. do. (resistance) supply-piston,	p'
Ratio of capacity for heat of air confined to constant volume, and expanding under constant pressure,	r

(r has already been described, and fixed at 1·324).

In fixing the mean pressure on the working and supply pistons, I shall, to avoid complicating the formula (the usual logarithmic formula cannot be used since Mariotte's law has been discarded), simply *average* the extremes of pressure at commencement and end of the expansion (or, in supply-cylinder, compression), which gives results differing little from the truth.†

By this method of calculation we shall have

$$P' = a\,t\,x + \tfrac{1}{2}\,a\,(1-x)\,(t+t') - 15\,a$$

$$\text{and } p' = a\,m\,t\,\frac{1}{d'} + \tfrac{1}{2}\,a\,m\left(1 - \frac{1}{d'}\right)(t+15) - 15\,a\,m,\text{‡}$$

hence,

$$P' - p' = a\,t\,x + \tfrac{1}{2}\,a\,(1-x)\,(t+t') - a\,m\,t\,\frac{1}{d'} - \tfrac{1}{2}\,a\,m\left(1 - \frac{1}{d'}\right)(t+15) - 15\,a\,(1-m) = a\left\{t\,x + \tfrac{1}{2}\,(1-x)\,(t+t') - m\,t\,\frac{1}{d'} - \tfrac{1}{2}\,m\left(1-\frac{1}{d'}\right)(t+15) - 15\,(1-m)\right\} \quad (1).$$

To make this expression available, it is necessary that t and t', or x and t', should be eliminated, so that either the cut-off or pressure being assumed, the working pressure shall be expressed in terms of them.

t being the tension or pressure in the working-cylinder, and d its density, it would, by the simple change of density alone (as compared with the atmosphere), become equal to $15\,d$; but the air, in its progress from the supply to the working cylinder, has received an accession of temperature τ, and by the law of increase of tension by heat.

$$t = 15\,d\left(1 + \frac{\tau}{491° + 28°}\right) = 15\,d\left(1 + \frac{\tau}{519°}\right)$$

And as the quantity of air worked off must be equal to the quantity furnished by the supply-cylinder, we have $a\,m = a\,d\,x$, or $d = \frac{m}{x}$ and substituting

$$t = \frac{15\,m}{x}\left(1 + \frac{\tau}{519}\right) \qquad (2).$$

But by Poisson's formula (1), we have

$$t = 15\,(d')^r \text{ from whence } d' = \left(\frac{t}{15}\right)^{\frac{1}{r}} \qquad (3).$$

We have by same formula $t = t'\left(\frac{1}{x}\right)^{r}$*

$$\text{from whence } t' = t\,x^r \qquad (4).$$

Substituting in equation (1) the values of t, t', and d', obtained from equations (2), (3), and (4), we shall have (putting for brevity, $1 + \frac{\tau}{519} = A$),

$$P' - p' = a\left\{15\,m\,A + \tfrac{1}{2}\,(1-x)\,(1+x^r)\,\frac{15\,m}{x}\,A - \frac{15\,m}{x}\left(\frac{x}{m\,A}\right)^{\frac{1}{r}} A - \tfrac{1}{2}\,m\left[1 - \left(\frac{x}{m\,A}\right)^{\frac{1}{r}}\right]\left(1 + \frac{m\,A}{x}\right) - 15\,(1-m)\right\}$$

This may be written

$$P' - p' = 15\,a\,m\left\{A\left[1 + \frac{(1-x)\,(1+x^r)}{2\,x}\right] - \left(\frac{m\,A}{x}\right)^{1-\frac{1}{r}} - \tfrac{1}{2}\left[1 - \left(\frac{x}{m\,A}\right)^{\frac{1}{r}}\right]\left(1 + \frac{m\,A}{x}\right) - \frac{1-m}{m}\right\}\text{†} \qquad (A).$$

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* This applied to air of any given density and temperature, is to be applied to the volume the air *would occupy* if cooled down to 32° under the same pressure.

† A similar error is thus introduced into the expression of pressure on the working, and resistance of the supply-piston; and the real error of the general formula is but the difference between these two, and is comparatively small, and in *favor* of the power of the engine.

‡ d' being the density in reservoir, $\frac{1}{d'}$ will represent that portion of stroke of the supply-piston, in which it acts against the full pressure t, of reservoir, and $1 - \frac{1}{d'}$ the portion in which it acts against a pressure increasing from 15 lbs. to t.

* $\frac{1}{x}$ represents the ratio of densities of the air before the cut-off, and at the termination of the stroke.

† A much more elegant solution, and one almost exact, may be made by supposing the extreme ordinates of pressure to be connected by a hyperbolic curve; or, in other words, using a hypothetic volume which will expand between the known limits of pressure, according to Mariotte's law.

Thus if the cut-off is at x, and the pressure is t at that point running down to t', the logarithmic formula is

$$(1). \qquad P = a\,x\,t + a\,x\,t\,\log.\frac{t}{t'}$$

The first term remains correct, whether Mariotte's law of expansion is used or not; but t and t' are not, in the case before us, in the relation to each other which that law would require.

The volume which expands is represented by the factors $a\,x$. Instead of using this volume, use a hypothetic volume, which would, under Mariotte's law, diminish in pressure from t to t', in expanding through the portion of the cylinder, denoted by $1 - x$; or, instead of $a\,x$, use a volume $a\,s$, and find s by the proportion

$$1 - x + s : s :: t : t' \quad \text{which gives}$$

$$s = \frac{t'\,(1-x)}{t - t'} \text{ or, substituting the values of } t \text{ and } t'.$$

$$s = \frac{(1-x)\,x^r}{1 - x^r}$$ Substitute this value of s in place of x, in the second term of the above equation (1), and the mean pressure on the working-cylinder will be obtained.

In the same manner, ($\frac{1}{d'}$ representing the portion of the supply-cylinder through which the resistance acts with full pressure t), the resistance of the supply-piston will be represented by

$$(2). \qquad p = a\,m\,t\,\frac{1}{d'} + a\,m\,t\,s\,\log.\frac{t}{15}$$

Or it may be expressed, perhaps more conveniently, in terms of t, thus,

$$P'-p' = a\left\{15\,m\,A + \tfrac{1}{2}\,(t-15\,m\,A)\left[1+\left(\frac{15\,m\,A}{t}\right)^{r}\right] - m\,t\left(\frac{15}{t}\right)^{\frac{1}{r}} - \tfrac{1}{2}\,m\left[1-\left(\frac{15}{t}\right)^{\frac{1}{r}}\right](t+15) - 15\,(1-m)\right\} \quad \text{(B)}.$$

In every engine, a and m will of course be known; the degree of heat in the working-cylinder must also be known, which determines A; t or x must then be assumed, and either of the formulæ will then give the mean working pressure of the engine.

To apply this to the Ericsson engines, we have

$$a = 22{,}300,\ m = \tfrac{3}{4},\ A = \left(1+\frac{380^\circ}{519^\circ}\right) = 1{\cdot}732.^*$$

To find the working pressure for the pressure adopted by Mr. Ericsson, put $t = 27$,† and by formula (B) (r being equal to $1{\cdot}324$, $\frac{1}{r}$ to $\cdot755$, and $1-\frac{1}{r} = \cdot245$).

$$P'-p' = 22{,}300\left\{17{\cdot}32 + \tfrac{1}{2}\,(27-17{\cdot}32)\left[1+\left(\frac{17{\cdot}32}{27}\right)^{1\cdot324}\right] - 18\left(\frac{15}{27}\right)^{0\cdot755} - \tfrac{1}{2}\left[1-\left(\frac{15}{27}\right)^{0\cdot755}\right](27+15) - 5\right\}$$

Executing the arithmetical operations indicated, we have $P'-p' = 74{,}036$, very nearly the same as obtained before by another method.‡

By using the air at a higher tension, or making t greater, a greater power will be obtained; but there are practical limits to this increase, as I have already shown, and Mr. Ericsson has good reasons for limiting himself to 12 lbs.

There is one more point of view in which I will consider the caloric engines. Mr. Ericsson has based his estimate of power upon a three-fourths cut-off, and a 12 lb. pressure, and a velocity of piston of 200 feet per minute.

The first requires 589° of heat, which I consider impracticable, and which I think all will admit as an extreme limit. The last (velocity of piston) is by no means a consequence of the first, and has not been promised by any thing we have yet seen. Admit them all, and the working pressure becomes 97,694 lbs. (Mr. Ericsson makes it 108,385 lbs., but I have pointed out so many errors in his calculation that I may be excused for making one of my own), and the aggregate horse-power 1184.

To give the caloric ship, in proportion to her tonnage, power equal to the Collins steamers, she requires 1760 or 50 per cent. more horse-power, requiring cylinders of 17 feet instead of 14 feet diameter.

Thus allowing every extreme claimed by the inventor, we have yet to enlarge her mammoth cylinders to 17 feet.* Does any one believe that a machine of this kind is likely to supersede the steam-engine, which has yet quite as large a field open to it for improvement of construction and economy of fuel, as the caloric engine!†

Yet one more remark on Mr. Ericsson's "observations," and I will close this too lengthy communication:

Since he has at last taken up his pen in defence of his own invention, one would have expected that the veil of mystery was at last to be broken—that such an array of *facts* would have been presented as would have put to silence all future critics.

But one may search his paper in vain for any thing of the kind. Except to give an erroneous theory of his own, and to make sundry assertions unsupported by any proof, the matter is left as he found it.

But had he given us the complete record of all his experiments, and all his trial trips, he could not more effectually have exposed the false foundation on which he rests.

His paper contains two prominent and vital errors: the first, that the heat developed by compression produces an increased volume in the working-cylinder, and an augmentation of power (which he has chosen to express by 299,462 lbs., raised "one foot high during each stroke"), has quite misled him in his estimate of the power of his engine.

The second—more dangerous still—the rock on which thousands of inventors have split before, the perpetual motion in a new guise—is found in the idea that his regenerators are the "principal source of heat," and hence that he can make heat do its work over again, or obtain from it more than its mechanical equivalent. Whatever unwearied industry and the highest degree of mechanical skill can do, may be expected from Mr. Ericsson; but *false theory* never yet produced substantial results, and it is to be regretted that the energies of his life have been devoted to a subject so hopeless as the caloric engine.

I am, very respectfully, your most obt.,

J. G. Barnard, Bvt. Maj. Engrs.

Lacey's Patent Apparatus for Raising Fluids.

The object of this apparatus is to render available a fall of water directed into a receiver of peculiar form, for the purpose of raising another body of water through a given space. A second portion of the patent describes the means by which the contents of a cask may be raised by employing the same moving force; and a third embraces a collateral object of utility, by describing the mode of forming a new joint for india-rubber, and flexible tubing generally, which dispenses with the application, for many purposes detrimental, of artificial cements.—*London Mechanic's Magazine.*

Fig. 1 is a sectional elevation of an apparatus adapted to raise water to the upper part of a building. A A is a vessel divided into two compartments by the flexible diaphragm, B D B. C is a vulcanized india-rubber tube, connected at one end to the diaphragm at d, and at the other end to a tube E. H is a cord or chain connected to the centre of the diaphragm, and passing through the tube E, and over the pulley J. I is a pipe leading from a water-tank above, and

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s is to be determined by the proportion

$$1-\frac{1}{x^r}+s : s :: t : 15$$

which gives

$$s = 15\,\frac{\left(1-\frac{1}{x^r}\right)}{t-15}$$

Substituting this value of s in equation (2), subtracting p from P, and deducting the atmospheric resistance, and substituting the values of t and t' and x^r, as obtained in the text, and reducing, we have

$$P'-p' = 15\,a\,m\left\{A\left[1+\frac{(1-x)\,x^{r-1}}{1-x^r}\log\left(\frac{1}{x}\right)^{r} - \frac{m}{a}\left(\frac{x}{m\,A}\right)^{\frac{1}{r}} - \frac{1-\left(\frac{x}{m\,A}\right)^{\frac{1}{r}}}{A-\frac{x}{m}}\log.\frac{m\,A}{x}\right] - \frac{1-m}{m}\right\}$$

For $m = \frac{3}{4}$, $a = 22{,}300$, $T = 380^\circ$, and $t = 27$, or 12 lbs. working pressure, x becomes $= 0{\cdot}641$, and $A = 1{\cdot}732$.

Substituting these and the value of $r = 1{\cdot}324$ and $P'-p' = 71{,}962$ lbs., differing little from the former determination, though, as it should be, it is less. The logarithms, of course, are hyperbolic.

The true curve of expansion is not really hyperbolic, but so nearly so that the above formula may be considered rigid.

For the above method of obtaining a logarithmic formula I am indebted to my brother, Prof. F. A. P. Barnard, of the University of Alabama.

* The heat in working-cylinder being assumed at 440° Fah.

† Within certain limits, t may be arbitrarily assumed, though the temperature of working-cylinder remains the same, as it only requires the cut-off to be adjusted to suit.

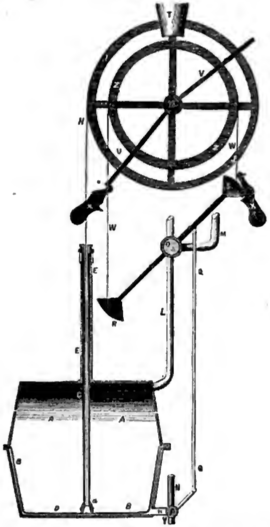
‡ No particular pains was taken to carry out the decimals in either case, hence the difference.

* It has been gravely stated in the public journals, that it was the inventor's original intention to put 20-feet cylinders in the Ericsson. Four twenty-feet cylinders! Four sixteen-feet supply-cylinders! Can any thing be more preposterous? Why, four *forty-inch* steam-cylinders, carrying one-fourth the pressure usually carried on the Mississippi, would have more power than those four colossal towers of iron.

† "There are no sufficient grounds for concluding that the improvements in the steam-engine subsequently made (since Watt and Hornblower), and extending down to the present time, have reached the highest point of the scale; on the contrary, there is strong evidence of the existence of a margin in the field of economy, in the working duty of fuel, ample enough to occupy the husbandry of many laborers for some time to come, and holding out the prospect of a good return."—*Tredgold on the Steam-Engine, Revised Edition.*

conveying the water which is to be raised to the upper compartment of the vessel A A. M is an ejection-pipe for conveying the water to its destination. N is another pipe for conveying waste water from a receiver into the vessel A, under the diaphragm. O and P are three-way cocks, fixed on the pipes M and N, and connected by the rod Q. R and S are weighted levers, for the purpose of reversing the cocks O and P, and are alternately raised by the cords W W, passing over a pulley Z. U and V are arms on the axis of the pulley for raising the catches X X^1, and relieving the weights R and S, in the manner explained below.

Fig. 1.



The figure represents the state of the apparatus when charged for delivering a supply of water to the upper part of a building. The weight R is represented as having been released from the catch by the arm U, where it has reversed the cocks O and P, so that the cock O opens up a communication between the lower part of the pipe L and the pipe M, while it closes the communication between the lower and upper parts of the pipe L. The cock P opens a passage from the pipe N to the pipe n, fitted to the bottom of the vessel A A, under the diaphragm B D B; and waste water being now discharged from any given elevation through the pipe N, will flow through the open passage in the cock P into the vessel A A, under the diaphragm B D B, which it will raise, thus forcing up the water above it in the vessel A A, to nearly the level of the vessel from which the waste water was discharged. The rise of the diaphragm, and the retraction of the vulcanized tube C, puts the pulley J in motion, which being assisted by the weight T, fixed on the periphery thereof, brings up the arm of the weighted lever R, until the weight on the end thereof is held by the catch X. At the same time the arm V on the axis of the pulley liberates the weighted lever S, from the catch X^1, whereby the cocks O and P are reversed; that is to say, communication is closed between the pipes L and M, and opened between the two parts of the pipe L; the passage in the cock P from N to n is closed, while that between n and Y, a final discharge-pipe, is opened. A fresh supply of clean water will flow from the reservoir through the pipe L into the vessel A A, will depress the diaphragm, and drive out the water under it through the pipe n, and open passage in the cock P, into the final discharge-pipe Y. The apparatus is now again in the position shown in the figure, and ready to continue its action in the same manner.

Fig. 2.

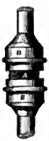


Fig. 3.

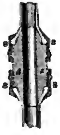
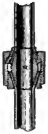


Fig. 4.



Where liquids such as beer are required to be raised from the cellar to the bar, the patentee proposes to insert a flexible diaphragm about the centre of the barrel, or other vessel in which it is contained. When the barrel is being filled, the diaphragm will be expanded against the end of the barrel, opposite to that at which the beer is admitted. An orifice for the admission of compressed air, or of a column of fluid, is provided behind the diaphragm, on the admission of which the beer will be forced upwards. Beer stored in vessels of this construction will be found to keep good a considerable time, as atmospheric air is altogether prevented from mixing with it.

Fig. 3 is a section of the joint for uniting two lengths of india-rubber or other flexible tubing. A is the body of the joint; B B, two collars which screw into a thread on the body A. One collar is placed upon each of the ends to be jointed; the ends are then each brought over the conical part of the body A, and the two collars are brought up and screwed thereto.

Where the length of india-rubber, or other flexible tubing, is to be united to a metal tube, the patentee employs one collar only, and connects the body of the joint on which the screw-thread is formed to the metal tube. Where liquids which would act upon metals are to be passed through the tubes, he forms the joint as shown in Fig. 4. A A is a piece of gutta-percha, glass, or other substance not liable to be acted on, which is inserted into the two ends of the tubes to be united, having, as before, passed one collar over each end of tube. One collar is tapped with a male, and the other with a female thread; the collars are brought up, screwed together, and thus form a perfectly tight joint. Fig 2 shows the elevation of the joint.

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Outlines of the Science of Mechanics.

No. 3.—Power or Work.

Pupil. You make frequent use of the term Power or Work. I understand it to mean the effect of an acting or dynamic force, in overcoming some resistance; am I correct, and do the two terms, power and work, mean the same thing?

Teacher. I mean the same thing by the terms whenever I have employed them. Various terms have been proposed by different authors. Smeaton used the word power to express this effect, which would still be preferable but for the chance of confusion with other uses of the word. Many modern writers use the word force in this sense, but as we have already assigned this term to the simple element of pressure measured in lbs., we will apply the term Work. You say vaguely, that it is the effect of a dynamic force in overcoming some resistance; very good, but does your idea of effect depend on *time* or *space?* That is, supposing the force to be constantly the same shall the effect be estimated by the number of seconds or minutes during which it overcomes the resistance, or by the number of inches or feet over which it pushes or pulls the resistance. These two modes of estimating may sometimes amount to the same thing, but often they do not.

P. I see that there are two legitimate ways of estimating the effect, and cannot say without more reflection which is the true measure. You are just in pronouncing my definition too vague. Tell me, if you please, which is the element usually employed, time or space?

T. This is the stumbling-block which, in the last century, set mathematicians at war, and many have not yet got the matter fairly straightened in their minds. For our present purpose, it is sufficient to answer distinctly, that space is the element required. Multiply the force by the space through which it moves the resistance, and the product is the work performed. The following unit of work can hardly be considered definitely and permanently established, yet it has been many times employed by eminent engineers. Multiply the force *in pounds* by the space through which it moves *in feet*, measured in the line of its direction, and the product is units of work.

P. Then if a horse pulls horizontally on a wagon with a force of 100 lbs., and continues this force till he draws the wagon 50 feet, the work performed in the operation may be obtained by multiplying the force and space together, thus, 100 × 50 = 5000; the figures 5000 then represent the work performed.

T. Correct. This is the unit which we will employ in our future investigations for the comparison or measure of quantities of work. As gravity is the most convenient to refer to, we may always compare with it as follows: *The unit of work is that necessary to raise 1 lb. 1 foot high.*

P. Very plain; the quantity of work is always estimated by multiplying the force into the space. Now, if I raise 1 lb. 100 feet, and you raise 100 lbs. 1 foot, we both perform the same quantity of work.

T. Exactly. The work performed or expended by each of us is precisely 100 units. In my case,

Force	Space	Work
100 ×	1 =	100.

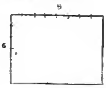
In your case,

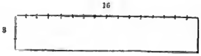
Force	Space	Work
1 ×	100 =	100.

This may be made plain to the reason by another method. Suppose, instead of lifting my 100 lbs. at one effort, I divide it into 100 portions and lift each separately, and suppose you to lift your 1 lb. through the 100 feet by successive lifts of one foot each, it will be seen that our jobs are so modified, that we each expend the same amount of work in precisely the same way; *i. e.*, we each lift 1 lb. 1 foot, and repeat the operation 100 times.

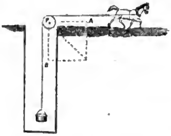
P. Very plain.

T. Every supposable case may be similarly analyzed with the same result, and it may be readily seen that every possible expenditure of work may be equalled by a similar amount in a different form. Work is, in short, a compound quantity, its elements are force and space; if one of these elements is increased, and the other decreased in the same proportion, the quantity of work remains precisely the same as before. This may be represented to the eye geometrically, by representing work as a surface, of which force is the length and space the breadth. If a force of 16 lbs. be applied till it has moved the resistance 3 feet, 48 units of work are expended; if the space be doubled and the force be halved, the work remains the same.





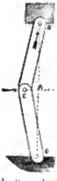
P. If a horse, acting horizontally on a rope which passes over a fixed pulley, pulls strong enough to lift 300 lbs., and continues the effort until he has travelled over a space of 100 feet, and consequently lifted the weight to that amount, let me describe the circumstances. The horse exerts a force upon the rope. The direction is horizontal, the amount is 300 lbs. I may further remark that the force is dynamic, as it overcomes and moves the resistance. The pulley changes the direction without otherwise modifying the force, so that the work in this case is expended in overcoming the gravity of the suspended mass. When the horse has lifted the 300 lbs. 100 feet, he has expended 300 × 100 = 30000 units of work. If now the weight be attached to some suitable machinery, clock-work, for example, and allowed to run slowly down, it will, in its turn, expend a like amount of work in turning the machine, will it not?



T. Yes. With the exception of the friction, the stiffness of the rope and the like (which are practical imperfections, always present in a greater or less degree), any weight in running down will give out the same amount of work as is required to raise it up, so that any amount of work may be compared with that given out by a certain weight *descending* a given distance, or that required to raise a certain weight *up* a given distance. Thus a unit of work is the work required to lift 1 lb. 1 foot, *or* the work given out or expended by 1 lb. in descending 1 foot. Practically it would take something more to lift 1 lb. 1 foot than could be obtained by its descent, because friction and other resistances, as we shall soon more fully see, are continually consuming work.

P. There are certain arrangements termed mechanical powers, the lever, the wheel, and axle; the pulley, the inclined plane, the wedge, and the screw; by these devices a small force called the power, applied at one point, is increased, so that a great force is produced at another point. In common language, a great "purchase" is obtained by these arrangements. But do these machines really increase the work which is performed?

T. Never. They neither increase nor decrease an amount of work except by consuming or annihilating a portion by friction. Machinery is merely a combination of masses of inert matter of various forms and can never generate work, but it may be the means of transmitting work through itself, of changing the direction of a force, as we found in the case of the pulley above, and even of interchanging the elements of work one for the other. That is, the mechanical powers increase the force by diminishing the space in a like ratio, or on the other hand, increase the space by diminishing the force. There are many forms of the six mechanical powers, and there are other devices for thus modifying and exchanging the elements of work which might be ranked in the same list. Among these may be reckoned the hydraulic press or hydraulic pump, of which latter form it is, perhaps, superseding the jack-screw, and the Tricardo toggle-joint or toggle lever, of frequent use in all kinds of presses, particularly printing-presses. One form of the toggle-joint, or rather the double toggle, is represented in the accompanying cut in which a force applied in the direction of the arrow A becomes a much greater force in the direction of the arrow B. But the space through which B is moved is just as many times less than that through which C is moved as the force is greater. I will tell you how to calculate the increase of force or the "purchase" of any mechanical device.



P. I am already familiar with the rules for the six old standard mechanical powers.

T. But I mean a general rule, applicable to every combination, however complicated. *The force is increased in the same proportion as the space is decreased.* For you find either by calculation or by actual experiment that a screw goes a head 1 inch while you move the handle of the wrench continuously in one direction 1000 inches, you may conclude that (friction, elasticity, &c., aside) the "purchase" of the contrivance is 1000 fold. This is not recommended as a substitute for the ordinary rules, but may be practically useful in many cases where a minute analysis of each part might be too troublesome. Its chief value may be to serve as a method of detecting accidental or mystified errors in the other calculations, as is sometimes the case in complicated attempts to obtain perpetual motion. It is in fact but another method of applying the usual rules.

P. I think I can readily obtain the "purchase" or power of each kind of machine yet mentioned except the toggle; how may this be estimated?

T. The power of this arrangement varies with the angle at which it stands. In mathematical language the purchase is inversely, as the *sine* of the angle by which it deviates from a straight line, joining the ends. More familiarly, referring again to the toggle above, the "purchase" is proportional to the ratio of the line B D to the line A C. When put in operation, the joint C moving towards the point A continually changes this ratio. In the position in our cut the ratio is 6 to 1, and the purchase is therefore 6 fold while the joint is in its present position, but by approaching nearer to the line B D, the purchase is increased, the same rule applying to it in any position. The toggle joint may also be employed as a purchase in drawing together the two points B and D. In this form a rope or chain is frequently used. A common, and the only old-fashioned way of securing skates tightly to the feet illustrates this application, and leather bands are very forcibly stretched on this principle in almost every manufactory. The toggle usually acts only through short distances, but an application of the same principle is frequently made on shipboard by drawing aside the rope when the resistance becomes too great for a direct pull, and by alternately swaying away and "rendering in," the operation becomes continuous and effective.

LIST OF PATENTS,

Issued from the U. S. Patent Office during the month of May, 1853.

A. G. Bachelder, of Lowell, Mass., for improvement in Countersinks.

Claim.—I claim an independent countersink, so constructed that it may be used on different sized bits, or other instruments for boring, for the purpose of countersinking, as well as gaging the depth of the hole at the same time it is bored, as described.

Nehemiah Dodge, of New York, N. Y., for improvement in the construction of Pump Valves.

Claim.—I claim an arched valve, formed by passing two planes, inclined to each other, through a semi-cylinder of the same diameter with the bore of the pump, the sectional valve thus formed being hinged by one vertex, to the interior of the bore, for the purpose set forth.

E. L. Evans, of Hartford, Ct., for improvement in the construction of Washing Machines.

Claim.—I claim the combination of the rubber and rod or handle, for the opening or closing said rubbers by the same handle with which the rubbing is performed.

I also claim the combination of rubbers E with the rubbers F, and bars, so that the two pairs of rubbers shall, each of them, grasp the cloth and rub it between them, as described.

T. S. Minniss, of Meadville, Pa., for improvement in the construction of Invalid Locomotive Chairs.

Claim.—I claim the combination of the wheel, axle, and shank on the end of the projecting-arm, by which a central support is given to the frame within the disk of the wheel, the bearing in the hub being central with the bearing of the rim, permitting a free lateral movement of the wheel, without changing its point of support to the frame, and enabling the wheel to receive any shock on its rim, with firmness, while its plain surface is left unobstructed from the free movements of the crank and handle.

Also, the arrangement of the adjustable handle, which can be used to pull the chair, or as a guide in the hands of the invalid, when pushed by another, or changed to a crank of various length of stroke, to suit the invalid, when he wishes to propel himself with his own hands. The materials used, in the construction of said machine, being wood, iron, or other material, as convenience or fancy may dictate.

J. W. Morrill, of Hampton Falls, N. H., for improvement in Ditching Machines.

Claim.—I claim, first, the employment of the swinging cutters, in combination with the swinging spade, the whole being constructed, arranged, and operated, as set forth.

Second, I also claim the combination of the swinging cutter, swinging spade, and lever, the whole being arranged in the manner specified.

Enoch Osgood, of Bangor, Me., for improvement in Fastening Leather Beltings.

Claim.—I claim the application of the tapering screws, with hooks and eyes screwed into the edges or ends of leather or belting, for the purpose of uniting the edges together, as described.

J. W. Richards, of Hoboken, N. J., for improvement in Registering Apparatus for Printing Presses.

Claim.—I claim, first, the circular slotted plate let in flush with the face of feed-board, and fitted so that it can be rotated, to bring its radial slot into any desired position, so to pass the registering point, as described.

Second, the spindle and arm connected to and combined with the circular slotted plate, so as to slide vertically, when actuated by competent mechanical means, and project the point through the slot in the plate, as specified.

J. P. Sherwood, of Fort Edward, N. Y., for improvement in Machine for Making Wrought Iron.

Claim.—I claim the combination of a revolving cam-drum, with the converging die stocks, moving in directions oblique to the axis, on which the cam-drum revolves, the cams being constructed, as set forth, with two curved faces meeting at an angle, the whole arrangement being such, that dies moving at right angles to each other are operated by a single drum, without the intervention of rods or levers.

Also the compound gage and nipper which acts as a gage to regulate the breadth of the nail-blank, and also as a nipper, to hold it firmly during the action of the pointing-die, the same operating as described.

F. E. Sickles, of New York, N. Y., for improvement in Operating and Controlling the Rudders of Steam-Vessels.

Claim.—I claim operating and controlling the rudder of a vessel, by combining with the steersman's handle and the rudder, with an engine so arranged as to move or to hold it, with and against the force of the propelling engine, as described.

J. H. Snyder, of Troy, N. Y., for improvement in Hook-Headed Spikes.

Claim.—I claim rolling wedge-pointed spikes between rotating dies, so formed that the face of one shall be the reverse of one face of the spike, when formed, and the face of the other die, to correspond, in the relation with the other face of the spike, as specified.

I also claim forming hook-heads on spikes, by rolling from the point towards the head to force the surplus metal towards the head, and then bending and giving the form required, by a lip on one of the dies, projecting beyond its face, so that it shall have an increased motion, by reason of its greater radius, to give the required form, as described.

Also, in combination with the dies for rolling the shank of the spike, making the heading lip, for forming the head, movable, by forming the said lip on the end of a bar, adapted to slide in the stock of the die, as specified.

Also, in combination with the rotating dies, the employment of the sliding cutter and carrier, as specified, for cutting from a rod the required lengths of rod, and carrying thereto the rotating dies, as specified.

And, finally, I claim, in combination with the rotating dies, the slides, for presenting and forcing the end of the rod into the rotating dies, to insure the proper position of the rod in the dies, as specified, for if the rod be not gripped by the dies at the proper time, there will be either too much or too little metal for the forming of the head.

G. A. Whipple of Newark, N. J., for improvement in Manufacturing Malleable Iron directly from the Ore.

Claim.—I claim forcing down upon the iron ore, from the roof of the furnace, in the different stages of the process, as required, and on the different hearths, atmospheric air, either heated or cold, for the purpose of decarbonizing the ore, and bringing the iron to nature or refining the same, and regulating the degree of heat, in the manner and for the purpose specified.

D. Winder, of Xenia, Ohio, for improvement in the construction of Locomotive Engines.

Claim.—I claim the employment of three engines, connected with a three-throw crank on the driving-shaft, with the cranks arranged at equal distance apart on the circle, as specified, when this is combined with the employment of valves, stop-cocks, or their equivalents, for letting the steam on both ends, or cutting it off from one end, to work the engines, on the single or double-acting principle, as specified.

C. F. Sibbald, of Philadelphia, for Paint Compounds. Patented in England, Oct. 15, 1852.

Claim.—I claim the compound of tallow, plumbago, and charcoal, as set forth.

J. Mee, of Lowell, Mass. (assignor to J. Mee & John Rourke, of Lowell, Mass., and Gilbert Mackennon, of Portsmouth, N. H.), for improvement in Knitting Looms.

Claim.—I claim the two sets of thread-guides, in combination with two sets of needles, or their equivalents, and machinery for casting the loops, the whole being made to operate together, as specified, not meaning to claim the invention of a single set of thread-guides in combination with two sets of needles, and machinery for casting the loops, as such is not new, but meaning to claim the invention of two sets of thread-guides, in combination with two sets of needles and machinery for casting the loops, as described, and operating together, to produce a ribbed knit fabric, as explained.

Also, causing the two sets of needles to work or move up or down, independently of each other, or in other words, so that one set may move downwards, or to be moved out of the way of the thread-guides, to be brought into operation on the other set, such improvement enabling me to bring or arrange the two sets of needles close together, and thus make closer work than can be produced when the two sets of needles are made to move in one direction (either up or down) at the same time.

John Mee, of Lowell. Mass. (assignor to John Mee & John Burke of Lowell, Mass., and Gilbert Mackennon, of Portsmouth, N. H.), for improvement in Warp Net Fabrics.

Claim.—I claim the new or improved manufacture of warp knit rib fabric, the same being made by means of two sets of hooks or needles, and two sets of warps or warp yarns, laid and looped together, and upon the said hooks or needles, as specified, and whether to exhibit ribs to equal or unequal widths on opposite sides of the fabric, as explained.

J. M. Patton & W. F. Fergus (assignors to J. C. Da Costa, of Philadelphia, Pa.), for improvement in machine for Tongueing, Grooving, and Moulding Cutters.

Claim.—We claim arranging the cutting-teeth on the periphery of a plate, inclined to the axis of its rotation, so that as they are rotated they shall correspond in reverse to the tongue and groove or moulding, to be formed thereby in the manner described.

James Young (assignor to J. W. Middleton, of Philadelphia, Pa.; antedated Nov. 10, 1852), for improvement in Printing Presses.

Claim.—I claim, first, the combination and arrangement of mechanism for operating the inking rollers, as described.

Second, a false bed hinged to a stationary one, and the mode of fastening the form to the bed, as described.

Third, I claim the eccentric in combination with the platen, by means of which the latter can be adjusted while in motion, or thrown off, for the purpose specified.

T. A. Chandler, of Rockford, Ill., for improvement in the construction of Pendulum Levels.

Claim.—I claim the method of supporting the angular journals of the arch of a pendulum indicator in turning and self-adjusting bearings, of similar form to the angular journals, as set forth.

Moses Coburn, of Savannah, Ga., for improvement in the construction of Violins.

Claim.—I claim the apertures in the sides, instead of in the top, and for producing the effect set forth.

Edwin Fobes, of Boston, Mass., for improvement in Vertical Pianos.

Claim.—I claim the arrangement of the straining-pins, with their axes, vertical or nearly so, and parallel, or nearly so, to the general plane of the strings, and to stand above the iron frame, as set forth, the string of each hitch-pin having guide-rollers applied to it, as set forth, my improvement enabling me to obtain sundry important advantages in the construction and tuning the piccolo pianoforte.

I also claim extending the sounding-board upwards, above the bridge, and in rear of the bridge-plate in the treble, and so as to be capable of vibrating, in rear and above said bridge-plate, as set forth.

Samuel Fox, of Sheffield, Eng., for improvement in the construction of Umbrellas and Parasols. Patented in England, April 6, 1852.

Claim.—I do not claim the bending or corrugating a metallic plate, or bar, for the purpose of imparting strength thereto. But I claim making umbrellas and parasols with ribs and stretchers of plate-steel, bent in the trough-like shape, as specified, in combination with eyes and connections, applied essentially as described, whereby they are rendered comparatively much lighter than, and still possess all the requisite strength of those made with solid or round rods of metal, in the ordinary way, and at the same time the formation of the eyes and connections is facilitated.

L. L. Gilliland & J. R. Wagoner, of Dayton, Ohio, for improvement in Sofa Bedsteads.

Claim.—I claim the hinged front board, so arranged that by the turning over of the seat, to convert the apparatus from a sofa into a bed, the front board shall turn down to prevent it from forming a hard ridge, under the sacking, which would be uncomfortable to lie on, and when the seat is turned back again, to re-convert the bed into a sofa, the front board shall be lifted up again by the act of turning the seat back into the proper position to support the sacking of the seat.

Also, the arrangement of the head and foot boards so that the act of shutting up the bed will depress them, and opening it out will elevate them again, as set forth.

The arrangement of the turning seat of the sofa, and the sackings of the bed and seat, in such a manner that, by the turning of the seat to form the bed, the sacking of the latter shall be stretched, and by the turning up again of the seat, to reform the sofa, the sacking of the latter shall be stretched, as set forth.

J. H. H. Hawes, of Ithaca, N. Y., for improvement in the construction of Calendar Clocks

Claim.—I claim causing a calendar clock to supply its own changes, for the irregularities in the length of the month, and showing on its dials the exact and no fractional parts of a day, week, or month, by means of the combination of the wheels, having thirty-one divisions, both of which run together, and independently of each other, at intervals, on the same arbor, and the lifting pieces for supplying the necessary changes in the length of the months, the whole being operated by the hook-piece, as described.

Also, in combination, the wheel of seven parts, working, spring-tight, with the wheel and the catch-piece, so that the two wheels may move together and independently of each other, for the purpose of allowing the day of the month indicator to run, during the time that the change is taking place from the end of a short month, to the beginning of the next month, while the day of the week indicator passes from one day to another, in regular succession, as described.

Matthaus Heim, of Cincinnati, Ohio, for improvement in the construction of Cooking Stoves.

Claim.—I claim the open-bottomed space or chamber, behind the fire, encircled at the sides and top, by flue, and closed at the ends, by shifting or movable doors, as described, constituting an accessible and well-ventilated arrangement for roasting purposes.

A. H. Longley, of Lebanon, Ind., for improvement in Cutting Wooden Screws.

Claim.—I claim giving an equal progressive to the cutting tools, in combination with a differential rotary motion, for the purpose of cutting the screws at the same time the hole is bored or the tenon is made, as set forth.

Frederick Mathesius, of New York, N. Y., for improvement in Upholstering Furniture.

Claim.—I claim covering the seats or other parts of upholstered furniture, or other articles and things, by means and with the aid of elastic ligaments or springs attached to the edges of the covering, and to the framework of the article covered, in such a manner that the outer or fancy covering, however much used or pressed down, upon being relieved from such pressure, will resume and retain an even and smooth surface, using for that purpose India-rubber springs, or any other elastic material, which will produce the desired or intended effect.

J. A. Pease, of New York, N. Y., for improvement in Seeding Hoes.

Claim.—I claim the combination and arrangement of a double-bladed hoe, with seed-box and drop, as described, for the purpose of planting separate kernels of corn at equal distance apart.

Wm. J. Thorn, of Westbrook, Me., for improvement in Pocket Combs.

Claim.—I claim the manufacture of pocket combs, with semicircular joints in combination with strips overlapping them, as set forth.

Wm. W. Wade, of Springfield, Mass., for improvement in Castors for Furniture.

Claim.—I claim the arrangement of the right-hand screw on the spindle, in combination with or respect to the arrangement of the left-hand screw, into the socket of the socket piece, and to the bearing surfaces of the said parts, whereby the spindle is not only preserved in the socket piece, by the two screws, but allowed freely to rotate, when its bearing surface is in contact with the bearing surface of the socket, as described.

H. D. Walcott, of Boston, Mass., for improvement in Graduated Cutters for Cloth and other substances.

Claim.—I claim, in its connection with the cutting knife, the improvement of making the bed to move or rotate transversely, in combination with the surface of it, which acts in conjunction with the knife, of variable length or lengths, in order, by moving or turning the bed around under the knife, different lengths of cut may be produced, as set forth.

Also, the improvement of combining with the knife and tubular cutter, and a rotary shaft or cylinder, placed under them, the two triangular or trapezoidal beds or surfaces, arranged on the shaft or cylinder, as described, whereby a cut or button may be made of any desirable length either with or without a hole at one end, as stated.

D. L. Weatherhead, of Philadelphia, Pa., for improvement in Cleansing and Cooling Block Dies in Rivet Machines.

Claim.—I claim clearing cinders, scales, and other obstructions, from a socket die, made in a solid block, for the purpose of heading rivets, by forcing in at the closed end of the die, a stream of water, that washes out the cinders, &c., every time a rivet is discharged; the inner end of the socket of the die being closed so that the pressure of the head of water, is rendered available, for forcing obstructions out of the die, as set forth.

S. J. Seely, of New York, N. Y., for improvement in Lime Kilns.

Claim.—I claim the process described of calcinating limestone in a kiln, by the aid of furnaces and an artificial draught of air, through the furnaces and the kiln, maintained by a mechanical blower.

I also claim the combination of a suction-blower at the top of the kiln, and a forcing-blower at the bottom thereof, as set forth.

Also, the method of regulating the production of steam, to generate the power for the engine, in proportion to the duty required of it, by setting the steam-blower in the same furnace that supplies the heat, for calcining the limestone, as described.

Wm. F. Ketchum (assignor to R. L. Howard), of Buffalo, N. Y, for improvement in Track Clearers to Harvesters.

Claim.—I claim the scraper or raking-board, constructed as described, and combined with the rake-piece at an angle less than a right angle, as set forth.

Richard Montgomery (assignor to Elizabeth Montgomery, of New York N. Y.), for improvement in Corrugated Plates for Steam-boilers, &c.

Claim.—I claim the corrugated metal plate, as described, with flat margins of greater thickness than its middle.

J. A. Woodbury, of Winchester, Mass., Joshua Merrill, of Boston, Mass. and Geo. Patten, of Charlestown, Mass., for improvement in the construction of Air Engines.

Claim.—We claim the mode specified of using air as a motive power, said mode consisting in the employment of a receiver, in which is to be highly compressed, heated, and maintained at or about a uniform pressure, a suitable working cylinder and piston with the ordinary appendages, an air pump, or pumps, worked by the engine for supplying the receiver, when the same are connected or combined with suitable devices, as set forth, for cutting off and working the air expansively, and according to the degree of compression of the air, as set forth.

We also claim, in combination with such an engine, the device for regulating the pressure of the air in the receiver, and economizing the power of the engine, said device consisting of the weighted bar, entering the receiver through a stuffing-box, and connected, at its opposite end, with the stop-cocks attached to the chambers of the air-pumps, as described, intending to use any known means for accomplishing the twofold purpose of regulating the pressure of air in the receiver, and opening the pump-chambers to the atmosphere so that the pump shall be relieved from unnecessary labor.

Wm. Cressler, of Shippensburg, Pa., for improvement in the construction of Seed Planters.

Claim.—I claim, in combination with the adjustable tubes, the seeding-wheel, with its flange and partition, for adjusting, receiving, and carrying the grain and other material to be sown with it, around the opening, whence it is conveyed to the ground.

Hiram Berdan, of New York, N. Y., for improvement in Machines for Pulverizing Auriferous Quartz and Amalgamating the Gold.

Claim.—I claim, first, attaching the ball or sphere, obliquely to the inclined shaft, by the pin-box and sleeve, as described, in combination with the inclined shaft and inclined bowl, as set forth.

Second, in combination with said bowl, I claim the heating-chamber or furnace, arranged, constructed, and operating in the manner specified.

Samuel R. Brick, of Philadelphia, Pa., for improvement in Gas-burners.

Claim.—I do not claim passing the gas through a small, long aperture, nor a sudden deflection of it, nor a descent of it, nor any of them together, less than the whole.

But I claim the arrangement and combination of the centre conducting-pipe and its capping-pipe, inside of the common burner, as described.

John B. Blair, of Alton, Ill., for improvement in an Engraving Machine.

Claim.—I claim, first, so combining the needle, whether sharp or blunt, with a pentagraph or other copying or tracing instrument, through the medium of double carriages, moving at right angles to each other, as that the dots or punctures of said needle may be dispersed or aggregated at pleasure, for the purpose of forming the lights or shadows, the character of the lights and shadows being indicated by a sliding scale moving before the eye, or under the hand of the operator, as described.

I also claim the combination and arrangement of the sliding-box on the bar, the three cords (one cord connecting the sliding-box with the spring lever, and two connecting the sliding box with the spring lever and pedal), and an arm, for the purpose of moving, by means of the pedal, the wheel x towards or from the centre of the wheel r, on the face of which it works spring tight, to change its motion and give to the needle a relatively changed motion, as specified.

I also claim, in combination with the carriage and needle, the wheel n, with its lifting-piece and the cam-wheel n, or their equivalents, for changing the character of marks, lines, or dots upon the plate to be engraved at pleasure, and this I claim, whether the same be operated in connection with the pentagraph or not, as described.

Thomas H. Dodge, of Nashua, N. H., for improvement in Kettle Bails.

Claim.—I claim the sliding dovetail, or other shaped piece, which the slides on the bail in combination with the female dovetail or other shaped groove, cast in the flanch or ear, either on the inside or outside, for keeping the bail permanently fixed in any position desired and for any length of time, and admitting of its being left loose, and operating, if desired, like the ordinary swinging-bail.

John C. Fletcher, of Burlington, Iowa, for improvement in Radiators for Stoves.

Claim.—I claim the interposition between the fire-chamber and the exit-pipe of a stove, of a series of concentric flues, so arranged as that the heat of one flue shall pass through the partitions, and in whole or in part, be transmitted to the next flue, or portion of the flue, in advance and prepare it for transmitting the draught through the series, as described.

John Martin, of New York, N. Y., for improvement in Water Meters.

Claim.—I claim the adjustable-box or stop on one end of the cylinder, for the piston to strike against, for the purpose of preventing the pin in the arm from straining upon the stop in the slotted arm, after the tilting of the lever, as set forth.

Lewis Lupton, of Winchester, Va., for improvement in the construction of Harrows.

Claim.—I claim the constructing the frame of a harrow, of double metallic bars, or of flat straps or pieces of metal and the forming of sockets thereon, by bending the metal, or otherwise, for inserting the teeth or tines, as described, and the uniting the bars, or pieces of metal, and the combining therewith, the manner of bracing or staying the same, by the rod and coupling, as set forth.

Stanlislas Millet, of New York, N. Y., for improvement in Meat Cutters.

Claim.—I claim the combination of a set of revolving knives, or cutters, with the top-plate and revolving-dish, formed as described, and arranged and operating so as to effect the sub-division of the matter by the action of the cutters upon it, in passing through the slots in the cover substantially in the manner set forth.

Thomas Nelson, of Troy, N. Y., for improvement in Watches and Chronometers.

Claim.—I claim the method of constructing watches and chronometers of any kind, so as to permit the employment of a spring barrel, of a size that shall occupy nearly the entire interior diameter of the watch-case or frame, and which I effect by placing the movements upon the top of the barrel and communicating the motion of the barrel to them, by means of a ring fixed on the interior of the case, or frame, with teeth on its inner edge, concentric with the barrel, into which teeth, the teeth of one or more wheels of the movements may cog, or take, as set forth.

Jeptha A. Wagener, of Pultney, N. Y., for improvement in Clover Harvesters.

Claim.—I claim for harvesting clover heads without the stalks the arrangement of the solid or hollow cylinder, set with knives on its periphery, as described, and just near enough to the fixed knife, as to the concave of the fingers, to admit space enough to allow the clover heads to pass through, without being crushed, and so that the combined action of the forward movement of the machine, and the adjustable guard-plate, and the knives, the stems may be drawn in and severed close to the heads.

Second, making the teeth, so that they will spring and vibrate, towards or from each other, as described.

Alexander J. Walker, of New York, N. Y., for improvement in Spirit Gas Lamps.

Claim.—I do not claim the employment of the inner wick-tubes, secured in a stationary bar, and having other tubes sliding over them, which extinguish the light, when the top of the lamp is unscrewed; but I claim the employment of the plate, which serves as a protection against the fluid rising and becoming heated and exploding; and also, as a support for the inner tubes, in combination with the spiral spring and rod, the rod serving to connect the said plate with the top of the lamp, and the spring serving to hold the plate firmly down on the flange, and also to throw up the cap and extinguishing tubes, instantaneously, after the top has been unscrewed, the whole being constructed as described.

Madison Page, of Williamsburgh, N. Y. (assignor to Samuel W. Hawes, of Chelsea, Mass.), for improvement in Process of Distilling Rosin Oil.

Claim.—I claim the employment, in the manufacture of rosin oils of different qualities, redistilling the same and purifying it, substantially as set forth, the introduction of the steam into the commencement of the goose-neck above the rosin in the still, so that the vaporized oils from the rosin will pass through and be commingled with said steam in their passage to the worm for condensation, for the purpose of purification, &c., as set forth.

Duncan E. M'Dougall, of Troy, N. Y., for improvement in the constructoin of Door Fasteners.

Claim.—I claim combining the levers or their equivalents, with the retaining lipped-plate, and claw-plate, and set-screw, or their equivalents, the said screw serving to operate the levers and force the plate, horizontally, against and under the door, and retaining it firmly in that position, by means of the same, and said levers, in the manner, and for the purpose described.

Philip H. Keck, of Morgantown, Va., for improvement in the construction of Cultivators.

Claim.—I claim, first, the combination of the balance-pivot, with a cultivator, constructed, as described, for facilitating the turning of the same, as specified.

R. H. Middleton, of Alexandria, Va., for improvement in the construction of Compound Rails.

Claim.—I claim the combination of the continuous case rail, with the split rail, the halves or parts of the latter being constructed with shoulders, that rest on the sides of the case rail, while their lower edges fit into and rest upon the bottom of the same, arranged as described.

Charles Neer, of Troy, N. Y., for improvement in the construction of Fire-places and Stoves.

Claim.—I claim combining with the fire-box of a fire-place, heating-stove, or furnace, an inverted pyramidal-shaped air-chamber, open at top and suspended over the fire, so that the inclined sides thereof, shall radiate the heat and throw it against the fire-box plates, on all sides; and this I claim, when the fire-box is flanked, or surrounded by a series of one, two, or more air-heating and smoke and gas flues, for the purpose of exposing all the heated plates to the current of air to be warmed and drafted into the room or apartment, to be heated as described.

Marie Louise Roucout, of Paris, France, for improvement in the construction of Grate Bars. Patented in France, Sept. 10, 1851.

Claim.—I claim the construction of bars of furnaces and other grates, of an arched or partly arched form, provided with two parallel rows of air-holes, as described.

Arnold Buffum, of New York, N. Y. (assignor to J. D. Lynde), for improvement in Gold Washer and Amalgamator.

Claim.—I claim, first, the furnishing of the centripetal discharging compartment, with a horizontally revolving water-moving and ore-guiding table, in combination with a discharging aperture, surrounded by a conical inclined plane at the centre.

Second, I claim the arrangement of the circular guiding channels, with connecting openings, so adjusted as to secure an irregular spiral passage from the periphery to the aperture of the centre; I claim these arrangements for gold separators, whether the centrifugal and centripetal compartments be used in combination or either of them separately.

Wm. H. Jennison (assignor to Chas. Millington, now deceased, and John Jordan, assignors to James M. Parker), all of New York, N. Y., for improvement in Compositions for a Filter.

Claim.—I claim the combination of animal charcoal, glass, and starch, or its equivalent, treated as set forth, for a filtering composition, as specified.

RE-ISSUES.

Cyrus H. M'Cormick, of Chicago, Ill., for Improvement in Reaping Machines. Patented October 23, 1847.

Claim.—I claim placing the gearing and crank forward of the driving-wheel, for protection from dirt, &c., and thus carrying the driving-wheel further back than heretofore, and sufficiently so to balance the rear part of the frame and the raker thereon, when this position of the parts is combined with the sickle-back of the axis of motion of the driving-wheel, by means of the vibrating lever, as described.

And I also claim the combination of the reel, for gathering the grain to the cutting apparatus and depositing it on the platform, with the seat or position of the raker, arranged and located as described, or the equivalent thereof, to enable the raker to rake the grain from the platform and deliver and lay it on the ground at the side of the machine, as described.

Late French Discoveries.

Self-Registering Compass.—M. Deleuil has presented to the French Academy a self-registering compass of his construction. Its object is to register the changes of direction in a vessel for every 3 minutes during the 24 hours. The marking is made on a compass-card; and it enables the captain to control with certainty the direction followed by his ship, and overlook most effectively the manœuvres of the steersman and pilot.

This self-register consists of three principal parts; 1, a clock-movement placed at the centre of the apparatus, for causing the point or pivot carrying the needles to move up and down at regular intervals; 2, an endless screw, furnished with a nut carrying the point for piercing the paper; 3, the compass-card, made of three needles fixed to a sheet of mica, a material as little hygrometric as possible. The mica is covered with a disk of velvet firmly glued to it by means of strong glue, and whose tissue has been saturated by a kind of glue that is soft when cold; on cooling the glue has an even surface, pierced with an infinity of pores, into which the point will readily penetrate after having pierced the paper compass-card. Owing to this addition, the process of puncturing does not stop the movement of the needle, a principle essential to the success of any method of self-registering.

When the needle is fixed towards the north, the axis or diametral line of the compass-card is placed in the line of the axis of the ship, and the punctures, made every three minutes, will indicate the deviation of this axis with reference to the magnetic needle: the succession of points, or the nearly continuous line which they trace, shows to the eye the course of the route.—*Silliman's Journal.*

Manufacture of Paper.—It is well known that paper which is very white when first made, often becomes yellow some time after being used. The yellow color is not always uniform, but often comes out in spots, more or less large, of a circular outline and a rusty tint. In some Paris manufactories, this defect (which is incorrectly attributed to an alteration of the fibre) is remedied in a simple manner, and as the process of discoloration may not be commonly used in America, judging from some paper I have seen, I make a brief mention of the subject.

The researches were made here by a manufacturer who combines in a high degree science and technology. M. Gélis recognized at first that the change of color was not due to any alteration in the ligneous fibre, and was owing to iron. But what the source of the iron? and how is it introduced? An examination of the manufacture, through its processes, shows that there is less iron in the pulp than in the paper made from it. The origin of the iron is hence not in the preparation of the pulp, but it must be attributed to the drying cylinders of steel under which it is passed while yet moist. The chlorine contained in the paste, and which it is very difficult wholly to remove by the washing process, becomes suddenly vaporized under the heated cylinders, attacks these cylinders, forms the protochloride ($FeCl$) which thence impregnates the paper. Colorless itself, this chloride gradually absorbs oxygen on exposure to the air, and thus the coloration takes place.

It is therefore not a remedy against iron but against chlorine that is required. The hyposulphite of soda is the simple antidote, and a very small quantity suffices to eliminate a large quantity of chlorine, since one equivalent of hyposulphurous acid requires four equivalents of oxygen, and therefore four equivalents of chlorine, to transform it into sulphuric acid.

For testing the complete removal of the chlorine, M. Gélis uses a liquor made of iodide of potassium and amidon (starch). This liquor becomes instantly blue if there is the least trace of chlorine.—*Ib.*

On coloring Silk through the Food of the Silkworm.—The interesting researches of M. Flourens relative to the coloring of the bones of animals through coloring matters taken with their food, are well known. These observations appear to have suggested an application of the principle which promises to make considerable stir in the silk interest. For some years it has been attempted to color the silk by feeding the worms with organic coloring matters, but till recently the results have been very imperfect, the colors being uncertain and not uniform or bright. The problem has not been altogether solved; nevertheless a long step has been taken through the experiments of M. Roulin, who has employed the *chica*, the red coloring matter used by the Indians of Orinoco for coloring their bodies. He sprinkles the leaves of the mulberry with this substance, and has thus obtained beautiful cocoons of a rose-red color, uniform in tint and apparently permanent.—*Ib.*

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Apprentices' Department.

Hints on Learning without a Teacher.

Mechanics are, in many cases, debarred from obtaining even a thorough academic training, and are forced by circumstances to don the overalls with no very decided taste for books or thirst for information of any kind. It is too often the case that young men of only middling energy are gradually drifted forward into active life with no definite end or aim, but this is foreign to our present purpose. Our present object is to furnish some hints, if the experience of another may be a guide, to those actually desirous of supplying, by diligent application, the deficiencies of an imperfect schooling, and of placing themselves, in some degree, on a par with the most book-worm graduate.

This is not impossible, nor is it in fact as difficult as may be imagined. In one point—the superiority of alternate study and labor, as compared with constant and unremitted study—the self-made, or rather the *self-making* man, has a decided advantage. Studying 10, 12, or 16 hours out of the 24, if it does not permanently break down is certain to temporarily impair the physical health, and through this channel weakens the mental power. And it may perhaps be assumed, as a general fact, that three hours study per day, under favorable circumstances, is at least half as effective as the greatest number which can possibly be endured without injury. If this be correct, if one studious hour of the workman is worth two or three studious hours of the professional student, the mechanic possesses facilities for self-instruction which he is almost culpable for neglecting.

To make studying without a teacher a still greater source of pleasure, shopmates may mutually agree to pursue together any particular branch; not to study together, but to compare notes, and comment on the points successively brought into view. Any larger combination of individuals for such a purpose is too apt to degenerate after a few efforts, and perhaps the studious man may find it difficult to find even one who will keep pace with him. Mutual assistance is desirable, however, when practicable, as the exercise of commenting on or explaining a point benefits both the parties.

To compensate for the absence of a teacher to consult on the knotty questions perpetually arising, use at the same time two text books. This is the most important suggestion we have to make in connection with the whole subject, and its value will be readily appreciated. It matters little whether it be a primary and simple "Introduction," or couched in the most abstruse and scientifically accurate language; even if it be an old and musty volume, without covers, title, index, beginning or ending, if it contains one method of presenting the subject, seize it and place it by the side of your principal and standard text-book. Two or three are sufficient. The language of one will be found to match over the joints in the other, elucidating the obscure passages, and preventing the possibility of misapprehension. In this recommendation we refer particularly to works on mathematics and kindred sciences, on which the various authors may be supposed perfectly to coincide. This plan of using two or more books tends also to correct a too common defect of school instruction—seizing and remembering the language without the ideas, a parrot-like power of re-echoing the sounds without fully realizing the meaning—a species of learning without knowing, of receiving and retaining without possessing.

While recommending this method for the full *understanding* of a point, the opposite course is preferred for *remembering*. Learning is a compound operation. To *master a subject* consult every practicable source: to *fix the result*, store one rule in the memory. The multiplicity of rules is rather an objection than otherwise to Greenleaf's highly popular arithmetic, as they tend to confuse the memory after a lapse of time. That rule for which the reason is most apparent, is preferable to an arbitrary and unreasonable one, even if the latter be a trifle shorter.

But however judicious may be the means employed for overcoming and obviating all unnecessary difficulties, the acquisition of knowledge, or rather that training of the faculties which may be properly called education, can never be accomplished without labor. There is no railroad up the hill of science, or, if such exists, there are no "dead-heads" among the passengers. The tickets must all be paid for, paid for in labor, and that, though pleasant, must be earnest and long continued. Industry, cheerfulness, and thoroughness must be the watchwords; and unless fully resolved on *application*, as well be content with a general undefined smattering, or a positively erroneous notion, as to attempt studying, for it is all you will obtain. The morning will be found the best period for deep and close thinking, the evening for remembering. In the morning the mind is clear, strong, and capable of penetrating at once the series of sentences over which the half-closed eyes at evening may run repeatedly in vain. On the other hand, the language of a rule, the enunciation of a general principle, a name, date, &c., left on the tablet of the memory during a night's rest is more indelibly fixed. But this may vary with the individual. Follow your own convenience or inclination in these respects, bearing in mind that the early morning hours are least liable to be interrupted, whether by your own inclination for amusement and social intercourse, or by the demands of others upon your time.

It may be needless to urge upon the attention of intelligent young men that their education, however favorable may have been the circumstances, can never be completed. There is always much to learn, always a boundless mine to explore, stored with the richest treasure to reward the seeker; and the man, young or old, who neglects to establish and carefully cherish a habit of close attention and diligent study in all matters which appertain to his business or profession, deserves what he is pretty certain to realize, an inferior, or, at best, a medium position under those who have been more fortunate or more industrious.

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Answers to Questions on pages 117 *and* 143.

13th. The pressure per square inch at a depth of 7706 fathoms is 20,585 lbs.

Solution.—The depth in feet 7706 × 6 = 46,236 feet. The weight in ounces of a column one foot square and 46,236 feet high, is 46,236 × 1026 = 47,428,136 ounces = pressure in avoir. ounces per square foot. This sum divided by 144, gives the pressure in ounces per square inch = 329,862, and this last quotient divided by 16, gives the same in lbs. 329,862 ÷ 16 = 20,585.

14th. The pressure on the beam will be (including the weight of the beam itself), $46\frac{2}{3}$ lbs. on one end (B), $25\frac{1}{3}$ lbs. on the other end (A): for the weight of the beam (12 lbs.) will impart to

support	A.	6 lbs.	B.	6 lbs.
The 36 lbs. weight gives	"	6 "	"	30 "
" 24 " weight gives	"	13·333 "	"	10·667 "
		25·333		46·667

The amount of pressure which a given weight exerts on either end of a beam, is found by multiplying the weight by the distance from the other end, and dividing the product by the whole length.

15th. The mass will be driven with the same velocity with as without the fender. This will be explained in Outlines of the Science of Mechanics.

16th. The power of the stream is 40 × 62·5 × 60 × 16 ÷ 33,000 = 72·727 horse-power.

17th. The power of the wheel = 72·727 × ·33 = 23·9999.

18th. 57·6 horse-power could be obtained for ten hours each day, for 10 : 24 : : 24 : 57·6.

[The answers to questions 14, 16, 17, and 18, are by M. Wright, Syracuse, N. Y.]

19th. There is a gain in time by the use of the light hammer with the vacuum, but of course no economy of power.

The question supposes 100 lbs. hammer and 200 lbs. vacuum, or 300 lbs. hammer and no vacuum. It is evident that the same amount of power is expended in throwing up the hammers to an equal height, each case being 300 lbs. resistance lifted to a certain height, and consequently it may at once be concluded that the same amount may be derived from its fall. To trace *how* this results is a little more difficult. The question includes a false supposition. The light hammer impelled by the vacuum will not return in one-third the time; if so, its blow would be much more effective. One hundred lbs. moving with three times the velocity of the 300 lbs., would strike three times as effective a blow. This is one of the difficult subjects which we are endeavoring to simplify in the series of familiar conversations on the Science of Mechanics. The 200 lbs. vacuum will not even double the velocity of the 100 lbs. hammer. The velocity will be 1·73205 times as great as if there were no vacuum, while the effect of the blow will be three times as great. The effect of the blow is proportional to the power expended, while the velocity is proportional to the square root of the power. The difference in effect between a sharp quick blow and a dull heavy one is familiar to every forgeman, and where the first kind of blow is wanted, this invention may be of advantage, as more work will be done at one heat than by the ordinary method. We see no advantage in it over a spring for throwing down the hammer, except that the blow may be modulated by valves. We shall present an excellent hammer for quick blows in our next number.

Correspondence.

For Appletons' Magazine.

Your Chronometers vs. Our City Clocks.

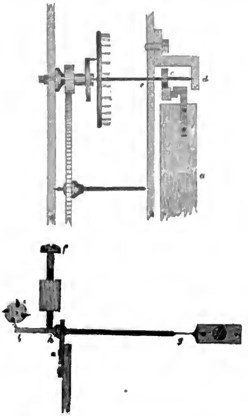
It is a singular thing that we, Americans, who have made such progress in the arts and sciences as to draw forth from our industrial competitors, the English, at the late World's Fair, the remark that "we had outstripped all the world in *useful* mechanical appliances and *practical* scientific combinations," and who are admitted even by our enemies to know the value of time, in fact, that "time is money," should, as your correspondent in the March number of your magazine remarks, be "far, very far behind some other nations in one thing," and that thing the means of keeping time; too truly does he continue, that "church clocks have been sadly neglected in this country." England, practical "Old England," has ever stood, and still stands pre-eminent for her time-keepers. Her watches, though massive as her steam-engines, have ever borne the highest market value. Her Frodsham, Dent, Tobias and Cooper in watches, with her Manton, Purdy and Richards in fire-arms, have handed their fame and names to posterity, and should still have held the palm, had not Switzerland, uniting the taste and delicacy of the French with the practical good qualities of the English, produced the most perfect pocket time-piece yet known, "the balance locking-spring chronometer." An ingenious London watchmaker once remarked, that "he could invent a new escapement every day for one year," yet neither has he nor any other given us any thing superior to the chronometer, the most perfect machine, probably, invented by man—a machine capable of being tossed for a cruise of three years on the ocean, racked by all its storms and pitched about by all its waves, and yet bringing its keeper safely home without having varied more than a few seconds!

The perusal of A. O. B.'s article, a recent visit to the new City Hall clock, the absolute necessity that exists in this great city for good clocks, nay, for a good clock, and the hope of attracting the attention of some of our scientific and enterprising capitalists to this national defect, has induced us to venture this article in your valuable columns. For weeks past has Wall-street been annoyed by the want of a clock in Trinity church. Is it possible that so splendid an edifice cannot get a clock that will show some other hour than twenty minutes to Ten!

We have just removed from the City Hall a clock that has been for some time past an object of derision to all, and replaced it, strange to say, in this age of improvement and competition, with one on *precisely the same old principle*, the only difference between the old and the new one being a trifling change in the weight of the crown-wheel and size of the pivots, while the principle remains the same as has been adopted for a century back, and is now actually set aside in London as *passé*, and that of the Remontoir adopted in its place. We believe that the maker, whose name we do not recollect, has engaged the clock for two years not to vary more than two minutes; now this engagement has doubtless been made in good faith, but we would like to know on what grounds, and do not believe it possible that the clock can perform its part, first, because its pendulum is uncompensated; second, because its hands, which are exposed to the weather, are in direct communication with the escapement; and lastly, because, although beautifully executed, its whole principle is wrong, and one that has already failed in similar locations almost without exception.

Our attention was directed to this subject about two years since by Mr. Robjohn, of the Bowery, one of the most scientific and celebrated chronometer-makers in this country, and twenty-five years ago the inventor of the Remontoire, who in reply to our question of "why have we not better tower clocks in this city," said that we had not a scientifically made clock in this country that he had heard of; at the same time handing us a London work published by Edmund Beckett Denison, M. A., for perusal. We there saw the principle of the clock made for the Meanwood church, with the "Remontoire escapement"—the same as alluded to by A. O. B., and by him first placed before the American public through your columns, to which we would refer your readers. Previous to pointing out its defects, and the mode of remedying them as proposed by Mr. Robjohn in a subsequent conversation on the subject, an improvement that renders this escapement as far superior to Mr. Denison's as the chronometer is to the Duplex, which his closely resembles, detaching completely the fly, except at the moment of unlocking, for it will be observed by reference to page 65, that the end of the fly in the London Remontoire, rests on the notched cylinder in precisely the same manner as the tooth of the crown-wheel in the duplex-escapement rests on the staff of the balance until freed by dropping into the notch, and possesses its disadvantages. Again, the arbor or staff of the crown-wheel, instead of running on two pivots, runs at one end on one, and at the other on a bearing precisely like a lathe pulley, causing great friction, which is further increased by the pressure of the fly on the cylinder.

Again, at each semi-revolution of the fly, a concussion is received upon the unslit portion of the cylinder, and however slight, is communicated to the escapement, a theoretical, if not practical, objection. The following wood-cut will illustrate Mr. Robjohn's improved locking for his tower chronometers.



A, the fly, same as page 65, whose projection rests on a jewel set in the locking-bar B, which is screwed on the frame of the clock, similar to the ordinary locking-spring for chronometers, and which receives the concussion of A, instead of the cylinder, p. 65.

C, a cylinder on the staff of the crown-wheel with four jewels revolving once in two minutes, unlocking by an inclined plane the spring B every half minute (dead beat).

D, the additional pivot of the staff of crown-wheel instead of a bearing at *e*, see cut, page 65.

F, set-screw to regulate depth of locking.

G, broad flat spring of locking-bar.

In next number we will give the drawings of the escapement, which is perfectly detached and dead beat, two qualities absolutely indispensable for accurate performance.

R. G. H.

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Water for Steam-Boilers.

Common spring-water is divided into hard and soft water. Soft water is freer than hard water from salts, which are disagreeable to the taste, and injurious in application. The salts are the *chlorides of sodium, calcium*, and *magnesium*, as also the *sulphates of the oxides of these metals*, and the *supercarbonates of iron and lime.*

These *supercarbonates* on exposure to the air, or particularly on heating the water, lose the excess of carbonic acid which keeps them in solution, and their neutral carbonates are precipitated. The carbonate of iron also absorbs oxygen from the air, its protoxide becomes hydrated sesquioxide, which falls down as a brown mud, by which deposit ferruginous waters are easily recognized.

These precipitates cause incrustation on the sides of the boiler, and make frequent cleaning necessary. Gypsum (sulphate of lime) is also very troublesome. The more soluble salts are of less importance, unless they exist in very large quantities, since a very considerable amount of water can be evaporated in the boiler before these salts accumulate in sufficient quantity to form incrustations. It frequently occurs that manufacturing and other establishments using steam-power are to be located with regard to the quality of the water. Of course, no absolute and general standard of purity for water can be given. There are also *organic ingredients* found in water, especially in that of low and marshy regions. They are partly dissolved in it, and partly held in it by mechanical suspension. Such waters, on being kept in a warm place, will soon putrefy, and slimy and vegetable deposits will be formed. The microscope is the best means for detecting these ingredients. For this purpose, however, the water must first be allowed to remain in a warm place for several days, so as to allow of the formation of the vegetable products just alluded to. If a little solution of perchloride of gold is added to such water, it will form a brown coloration. In waters which abound in organic matter, this coloration will follow almost immediately; in others, after several hours standing.

The question, as it occurs in practice, is to ascertain the relative fitness of several waters which may be available in the same localities. Thus, in localities where very pure water does not occur, a larger amount of impurities must be allowed than in other localities. To examine water for the use of steam-boilers, boil down one or two quarts in a small porcelain dish to one ounce, filter through a weighed filter, wash with a mixture of equal parts of alcohol and water, evaporate the filtrate, in a weighed porcelain or silver dish, over a water-bath to dryness. The filter, after being dried in the water-bath, is weighed, and also the porcelain or silver dish, after having been dried at 225° or 240° F., which is best done in an oil-bath. By the first operation we get an idea of the amount of the difficultly soluble substances in the water, and by the latter the amount of the easily soluble constituents. The filter is washed with dilute alcohol, as above, instead of water, to prevent the solution of the gypsum which may have been deposited during the evaporation. On comparing the results thus obtained with those from different waters, an inference may be drawn as to their relative value for supplying steam-boilers.

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[For Appletons' Mechanics' Magazine.]

On Warming and Ventilating Houses.

No. 1.

It is an admitted fact, that pure fresh air is necessary and indispensable for the health and comfort of every human being. Nature, ever various, and at times apparently arbitrary and unequal in her dispensations, has so ordered it, that at one season of the year man is furnished gratuitously with heat, and at another almost entirely deprived of it, and left to his intuitive and reasoning faculties to provide for its absence. If, indeed, all the habitable portions of the globe were similar to the table lands of Mexico or South America, and hung midway between extreme heat and extreme cold, possessing a climate like that of the favored and beautiful city of Jalapa, the startling necessities of provision for the absence or presence of heat or warmth would be obviated, and men might treat with becoming indifference the important subject embraced in our title.

But, alas! for the sun-basking and ease-loving portion of the world, our climes are more fruitful in extremes of temperature than Jalapa, or any other favored spot in the tropics. The noon-day glare and heat of summer, oppresses and wearies by its sinking recurrence. The cold chill of the north wind in mid-winter causes a sigh of regret for the season that we just parted with so gladly. Left to our wits (unlike other animals) for covering and shelter, we betake ourselves to warm houses and warm clothing. In the olden time, before the sharp axe of the woodman had slain the forests, the blazing and capacious hearth-fire sent forth its cheerful rays of light and heat upon the merry circle that surrounded it. Coal had not yet shown its utilitarian face, disturbing the quiet hearth scene; nor had lack of trees prevented the munificent heapings-up of the logs upon the glowing embers.

However, all this has disappeared. Wood, for fuel purposes, has, in thickly settled portions of the world, become almost obsolete, and men have betaken themselves to the bowels of mother Earth to glean a fitting substitute. The capacious fire-places of the olden time have disappeared with the last of the blazing logs; and grates and stoves, and such like devices, have coolly (if, indeed, we might be permitted to use such an expression) usurped their places.

The vegetable production called coal, changed somewhat by the subtle hand of nature, is more prolific of noxious gases, and other death-dealing qualifications, than its predecessor, wood. Its calorific resources, in the same space, are much more concentrated and powerful, and the small modern stove or grate, when suitably organized, now affords us as much useful warmth as did the unphilosophical air-openings and smoke-outlets of our worthy and self-satisfied ancestors. But, with all their want of philosophy, these same capacious chimneys were not bad for a free escape of the deleterious gases, which, in these latter days, are made to travel "cabined, cribbed, confined," through flues or pipes of a most intricate and labyrinthic character. Stoves, too, are made with joints and cracks innumerable, through which occasional downward puffs drive noxious and unhealthy vapors.

It is a very singular mistake on the part of the present generation to twist and torture the shape, and to draw out the length, of their stove flues or pipes, when it is philosophically obvious, that if the heated air, gas, smoke, and other volatile products of combustion, are robbed of their caloric by the conducting chambers through which they are obliged to pass, and are rendered comparatively cool at the point of entrance into the chimney, that they will not and cannot rise; for the only principle of levity (heat) that should characterize them, and which is absolutely essential to their ascent, is wanting. Who does not remember, in the far-off days of his boyhood, the worthy sexton of some country church, vainly endeavoring to warm it by the use of a huge stove with a very long pipe, and the clouds of tearful smoke that invariably poured in a backward volume from every nook and crack? How many times has the worthy man peered up and down the rebellious chimney, to see if aught was lodged there that could obstruct the draft; or in his very soul cursed the unlucky mason that built a chimney that would not draw! And then, too, the sagacious schoolmaster and chorister of the village, feeling deeply and personally, perhaps, the stinging necessities of reform, suggested, in the plenitude of his wisdom, *pots*, or a broad stone set up on four bricks, to be placed on the top of the faulty chimney, which still perverse, in spite of those improvements, would not draw. It never occurred to these wise-heads that the long shining pipe, that ran along under the galleries, stole away the caloric from the gas and smoke in their passage, and left the latter a dead mass at the base of the chimney, weighed down immovably by the superincumbent cold air. And those mysterious tin pans, or boats, hung under the joints of the pipe—what were they for? Verily, thy office, old man, in mid-winter is no sinecure, though huge stoves and brave piles of wood lie at thy command! Neither pots, nor broad stones, nor frequent peerings into, nor brushings out of the faulty chimney, nor private maledictions on the builder, will remove the difficulty, or remove to any considerable extent the smoke that persists in attending divine service.

Long and direct chimneys of brick, or other non-conducting substances, when kept free from soot, will not absorb so much of the caloric of the smoke as to obstruct its passage upwards and outwards. In country churches the absurd and ancient practice of using long metallic pipes should be at once abandoned. The stoves and chimneys should be placed near the entrances, and short competent communications made between the two. The sexton will find his house warmed in a better and speedier manner, and his friends the chorister and schoolmaster, to say nothing of the entire congregation, will be better pleased.

In a thousand instances in every-day life, similar unhealthy and unphilosophical practices can be observed. The bedrooms of children are not unfrequently warmed by what is humorously called a *drum;* which is nothing more or less than a devious and pent-up pipe, through which the heated gas and smoke of the kitchen stove is made to pass, from early dawn to late at night, filling the room with its dead gas and vapor, which are robbed of vital levity sufficient and necessary to carry them upwards through the chimney to the open air. In some, and not unfrequent cases, I have known a kitchen stove to send its volatile products through several floors, by ingenious and labyrinthine arrangements of pipes and drums, until, at length, perfectly enfeebled in their tortuous ascent, they had just strength enough left to crawl out through every crack and cranny into the sleeping apartment of some human being. Many cases of "smoky chimney" might be cured by a little reflection on the due location and arrangement of the stoves and escape-pipes.

In addition to the sickening and fatal influences of the gases generated by combustion when thus forced into our habitations, it must be remembered, that circuity of route for smoke impairs sensibly, and often totally, the proper draft of the fire. Smoke-pipes or flues should be short, unobstructed, and direct, and when thus used little or no danger of unhealthy influences is to be apprehended. The following simple and ordinary illustration of the intensity of *direct draft* will explain also its advantages as last suggested, in the matter of kindling or starting the fire. A common grate generally has a direct communication with a direct and unobstructed chimney. When covered with a blower, for kindling purposes, its draft is intense, roaring almost like the ocean. If, however, this grate should only communicate with the chimney by means of twisted pipes or drums, its draft would be found to be enfeebled and scarcely perceptible, and it would, in all respects, substantially resemble, when thus arranged, an ordinary stove with a drum; showing conclusively the superiority of direct and unobstructed egress to the chimney, even in the simple matter of kindling the fire, which *practically*, sometimes, is a matter of great difficulty and vexation.

The length and size of the chimneys should be proportioned to the size and intensity of the fire; and as this varies by circumstances, it would be almost impossible to lay down precise rules for their construction. Brick and stone are good non-conducting substances, and best fulfil the office of *material.* Long metallic pipes, exposed to cold winds, or in high situations, should be abandoned. If such must be used, pipes of earthen-ware might be suggested as constituting suitable and sufficient substitutes, inasmuch as they are non-conducting, inexpensive, and equally durable. Turns and twists, though sometimes necessary for space-sake, in general should be avoided, on the very obvious principle, that as heat, of its own motion, rises directly, the egress of heated gas and smoke is best facilitated by direct and open chimneys, and that every crook or bend is a formidable source of friction, and consequent obstruction. Soot is also a prolific source of conduction as well as friction. Its long accumulation lessens the aperture of passage, sometimes to a formidable extent, and many instances of complete obstruction are produced by negligence or inattention to its removal. In addition, the combustible qualities of soot often lead to disastrous results.

M.

(To be continued.)

Recipes for Compositions.

New York, Monday, May 23d, 1853.

Mr. Editor: Sir—The following reliable compositions have been kindly handed to me by my esteemed friend and old acquaintance, Mr. John Dekin, conductor (since its establishment) of the Brass and Iron Founding department of the Globe Works of this city, and for many years previously conductor of the Messrs. Fairbairns' foundery department, one of the largest and most eminent engineering establishments in London.

Respectfully yours, L.

No. 1. Best composition for steam cocks, copper 10 lbs., tin 1 lb.

No. 2. Best composition for hydraulic press, pump work, &c., copper 87 lbs., tin 12 lbs., zinc 1 lb.

No. 3. For casting solid air-pump rods, copper 6 lbs, tin 1 lb.

N. B. This metal does not generate much gas, is the best and most homogeneous mixture for the purpose, preventing the necessity of plugging, provided the rod be made cherry-red. Copper should, in all cases, be melted under a charcoal flux, otherwise, it oxidizes and becomes impoverished in strength and beauty.

New Publications.

"Treatise on American Engineering. Illustrated by large and detailed engravings." By Frederick Mone, C. E. H. S. Samuels & Co., New York.

This book is original and unclassible. To convey a complete idea of its character and contents, we should transfer into our columns the whole of the text, with a liberal addition, by way of marginal notes, explanations, and references. The elevation of the inclined engine accompanying our present number, is transferred almost without alteration from one of the large engraved lithographs of this work, and is by no means an extraordinary specimen of the accuracy of this department. The elevations of the engines of the unfortunate Reindeer, are without exception the finest of the kind we have ever examined.

Proofs of Division A, River-Boat Engines, are now before us complete. A very brief examination suffices to show that the work is not a treatise in any ordinary sense of the term. Its range of investigation is not sufficiently extended to entitle it fairly to the designation even of an essay. Its space is too limited. It has been issued in numbers, plates and text, nine numbers completing this important division of the subject. Each number has presented eight quarto pages of matter, illustrated by four drawings 15 by 24 inches, or by two of double that size. And here we are already in error, for more properly the text is secondary to and illustrative of the engravings. The work is unique and original in style, form, design, material, and execution, so much so, that it becomes difficult fairly to present its merits or demerits in a brief review.

Its faults, it is fair to say in commencing, are only such as must necessarily attend any positively original work of the kind, especially if mainly prepared as in this case, by those but imperfectly acquainted with the language. The nice distinctions of meaning which can only be mastered by long familiarity with our idioms and our technicalities, are to a considerable degree wanting in this book, and words are jumbled together in a style sometimes positively amusing. The Anglo-Saxon race are really the most conceited now on the face of the earth, and English and American writers are probably as prone as most others to the "great i and little you;" but we have a smooth way of saying it, which prevents it "sticking out" very conspicuously. So also in attempting to cajole an individual or a class, the native tongue is easily handled, but the half-anglicized European can deal only in up and down positive expressions. The *plus grand* of the Gaul is always more or less ridiculous to our ears when applied to common every-day objects, and some portions of the book before us are liberally sprinkled with equally awkward expressions.

These faults are all on the surface. They may be readily appreciated on the most cursory examination, and by the smallest possible exertion of the faculties. But they are *only* on the surface, and the merits of the plates will not be diminished in the eyes of the well informed by the fact that they are accompanied by a somewhat shabbily written description. This is perhaps the briefest and most comprehensive description of this production. A German engineer has accomplished what competent Americans have neither time, taste, nor patience to execute, and has placed within the reach of all, accurately engraved plates of the finest specimens of American River-Boat engines. One engine only of each class is illustrated, and this is sectioned and detailed with the most scrupulous fidelity from working drawings obtained from the shops for the purpose. To the amateur and engineering pupil, to the young mechanic training himself in mechanical drafting, and to the practical engineer of every nation, these plates alone are almost invaluable. The estimation in which they are held by the advanced members of the profession, is sufficiently indicated by their reception; the proprietors and principal draftsmen of the large shops in this vicinity, the owners and chiefs of steam-ship lines, naval-steamers, &c., being almost universally subscribers. An effort involving this amount of labor, will not be neglected at a distance by the large class whose patronage it claims. American engines have, until quite lately, been represented only in English works, the descriptions being often erroneous even in the names of the builders, and the books by Gen. Stuart, noticed on page 95, and this by Mr. Mone, together comprise almost the only American books on the subject worthy of the name.

This work includes in three other divisions the subject of Marine, Locomotive, and Stationary engines, which we shall probably take occasion to dissect as they are successively completed. The present division is confined to River engines, of two classes, beam and inclined, low pressure, and to boilers, gages, manometers, and cut-off motions. In addition to these may be reckoned a rather inconsiderable treatise on steam, a brief history of the introduction of steam-navigation, and a number of rules for proportioning the parts of engines. A table of the density and pressure of steam composes the gist of the information on that subject, and is entirely valueless on account of not giving the authority on which it is based. The rules for proportioning the parts, all referred to the diameter of the cylinder, are but little better for practical purposes, but these matters occupy but a small portion of the space. The book is essentially a splendid collection of detailed drawings with explanations, and as such deserves what it can hardly fail to receive, an extensive circulation both at home and abroad. We commend it to the favorable attention of all our schools of the higher grades, the institutes now so generally established in various quarters, the public libraries generally, and particularly to individuals interested, pecuniarily or otherwise, in steam navigation. Alleged improvements, wonderful discoveries, &c., perpetually arising, cannot be properly appreciated without a knowledge of the present position of engineering, and we know no work which can compare with this either in design or execution as an exhibition of Modern American Engineering.

Monthly Notes.

Prof. Wm. H. Ellet, in a letter to the New York Tribune of June 29th, gives the results of some recent and careful experiments on the presence of lead in water drawn from the service pipes of the Croton Aqueduct. The experiments of Prof. Christison of Edinburgh, confirmed to some extent by those of Prof. Horsford of Cambridge, on the Cochituate water of Boston, went to establish the formation of an insoluble lining on the interior of the pipes, protecting the lead from any other than a temporary action by the water. The late experiments by Prof. Ellet, were performed at the Medical College, in presence of a number of savans, and lead to an entirely different conclusion. A large number of medical practitioners appear to have been distrustful upon the subject, knowing that water containing one grain, or even one-seventh of a grain of lead per gallon, has produced injurious effects upon the human system, and that distilled water, containing only gases absorbed from the atmosphere, can hold in solution, according to Fresenius, 7 grains of the hydrated oxide of this metal. Prof. Ellet concludes, 1st, that the Croton does not contain saline matters sufficient to influence this result, although it may never be contaminated to that degree by simply standing in lead pipes; 2d, that the Croton always contains free carbonic acid, which changes the soluble oxide to carbonate of lead; and 3d, that of the carbonate thus formed part is dissolved in the water by an excess of acid, and part deposited in an insoluble form on the interior of the pipe, or remains mechanically suspended in the water, both forms being believed to be equally poisonous, but the latter being capable of being stopped by a filter. The presence of lead in both these forms was sensible in water which had stood 12 hours in the pipes of the Medical College, which pipes had been in use about 9 years. In another case the lining of the pipes, a reddish-white substance, easily brushed off by a camel's-hair pencil, gave an abundant precipitate of sulphuret of lead. Prof. Ellet proposes to continue his experiments, and to propose what he considers a remedy.

The Mechanics' Institute in this city is making an effort for increased efficiency and usefulness. The Institute is under the care of Mr. James Henry, as Actuary. We invite the attention of readers in this vicinity to this institution. Rooms, No. 1 Bowery. Regular meetings, second Tuesday of each month, at 7½ o'clock. The Engineers' institute has been removed to rooms at No. 297 Bowery, but shows very little activity or usefulness at the present writing. Meetings Thursday evenings, at 8 o'clock. The Inventor's Association, noticed in a previous number, has relapsed into obscurity, from which it will not probably emerge until after the opening of the Exhibition. The American Institute will probably long continue to be the most flourishing in New York. The Institute, if we rightly apprehend its position, throws the whole discredit of the "Ray premium affair" upon the committee appointed by itself and composed of its own members. The merits of this question we have never sufficiently investigated; the prominent facts in the case being simply this:—that liberal premiums were offered, but not paid, for the best unpatented improvements in railroad cars. We have always been inclined to attach the ignominy of the whole affair to Mr. Ray, the promiser of the premiums, believing he could have induced prompt action if desirable. The rooms of the American Institute are at 351 Broadway. Open at all hours.

The construction of the Delaware breakwater has been again resumed. The undertaking was commenced under General Jackson's administration, in 1829, and the work was continued uninterruptedly until the Autumn of 1834, when it was discovered that the space inclosed was filling up with sand, in consequence of the change of current. Operations after that date were, in consequence, confined to completing that part of the work already commenced, up to its proper height, and the work has remained in its imperfect state until the present season. Careful observations have established the fact that the harbor has now assumed a new regime, and the deposits of sand having entirely ceased, it is hoped it will not again commence with the further progress of the construction. There has now been expended in all on this work a little less than $2,000,000: the whole estimated cost is about $2,750,000. The work is now under the supervision of Brev. Maj. J. G. Barnard, the chief of the Tehuantepec surveys, but better known to our readers as the author of the mathematical examination of the caloric engine, in our present and former numbers.

Various devices have been invented at various times for insuring more fully the safety of cars and their contents in passing switches, draws, &c. One of the latest we have seen noticed is by Mr. M. S. Beach of this city, and consists in part of a communication by cords or small chains between the switch or drawbridge and a sufficient number of signal boards at a distance, the signals being at night exchanged for colored lights. All such arrangements, as well as those for operating the switches by the motion of the approaching train, seem greatly liable to derangement. Will some one inform us of the successful operation for any number of weeks or months of any such plan, and the details of its construction.

Messrs. Chambers & Heiser offer to sail the "Sweepstakes," a clipper ship of 1600 tons, partially launched on June 18th from the ship-yard of Messrs. Westervelt & Sons, in this city, a race of 3000 miles, say 1500 out and return, each ship to pay an entrance of $10,000; the race to be subject to such rules and regulations as shall be prescribed by the New York Yacht Club. The launch of this finely-modelled ship was arrested on the 18th by an accidental spreading of the ways as she was moving into the water, causing her to careen over and stop, in which awkward position she remained until Tuesday the 21st, when the launch was finished.

The Geological survey of Illinois now in progress, has been nearly completed along the southern border. "The two great staples of the south," according to an official report of the progress lately printed among the legislative documents, "are iron and coal, and both exist in such quantities as will render them fertile sources of wealth, prosperity, and power." Among the clays one is found "suitable for the best varieties of porcelain ware."

In connection with swift steamers, fleet clippers, fast trains, &c., we may be excused for noting the fastest trot yet on record. In the late race between "Mac" and "Tacony" near Philadelphia, the mile was trotted in 2 minutes 25½ seconds, and again repeated in the same time, Tacony winning each heat by about a head.

A rotary steam-engine, invented by Mr. Ebenezer Barrows, of this city, has attracted considerable attention by the smoothness and efficiency of its operation. This gentleman constructed a small one some two years since, which will be in operation in the machinery department of the Exhibition. The larger engine now alluded to was completed during the last summer, and has, we are informed, been in almost constant use without the slightest touch in the shape of repairs or adjustment. This engine, which measures, externally, 40 inches in diameter, and 26 inches in length, and weighs about 3,500 lbs., is fixed directly on the centre of the main shaft of a finely-modelled boat, 75 feet in length, 18 feet wide, and drawing 30 inches water. It is reversed by one movement of a lever. There are no dead points or inequalities in its force, and minus the leakage (which from its construction may be assumed as very slight), every inch of steam expended is effective, there being no loss in the passages, clearance, &c., as in a reciprocating engine. The boat as now arranged has probably a greater power in proportion to her size than any other afloat. The pressure on the shaft is exactly balanced by taking steam at two points, and *the* great objection, the conical wearing of the ends, is entirely obviated. It is high-pressure and non-expansive. We consider this engine in its present form superior, in almost every point of view, to Wright and Hyatt's Elliptic Rotatory, which appears to receive so large a share of attention from our English neighbors. (See pp. 33-35 of this volume.)

We shall illustrate this engine in our next issue, both in its present form and with a simple improvement, by which (without any fluctuation in its working force!) it becomes both expansive and condensing.

We have personally "dissected" the small engine, and witnessed the working of the larger one. The engine is powerful, compact, light, works off any quantity of water from a foaming boiler with perfect indifference, requires little attention, and is ready to act in either direction with its full force, in any position, without vibration, and without noise, excepting from the exhaust. Its first cost, general economy, friction, and durability, may be better appreciated after an examination of the drawings.

The Saut Ste. Marie ship-canal has at length been commenced, and several hundred men are by this time at work. "Half way across the portage," remarks the Lake Superior *Journal*, of June 11th, "is the steamboat Sam Ward, on her land journey to Lake Superior. It is a spectacle of continual interest to see a large steamer thus drawn over land, and spectators throng the place to witness this land sailing. This is likely to be the last vessel that will be hauled over the land, and this one is just in advance of the canal work. Right in her wake workmen are excavating the soil and rock over which she has just passed."

Edward H. Broadhead, C. E., writing to the Milwaukie News upon the gage of railways, says he found on curves on the New York and Erie Railroad (6 feet gage), that a shaving of iron from the outer rail was left in the track for nearly the entire length of the curve, after the passage of trains. He infers that the pressure of the flange against the rail, and the consequent resistance, must be enormous.

The old U. S. frigate Constellation is undergoing the rebuilding process to which we have before alluded as a favorite manœuvre in our naval tactics. We once knew an ingenious but ignorant man who was said to have built himself a good fishing-boat by buying a rotten one for a trifle, and replacing each piece by a new and sound one. Have not American shipwrights more confidence in their ability to originate than this fisherman?

The American Association for the advancement of Science, is announced to meet at Cleveland, Ohio, on the 25th of July. The meetings of this Association are annual, but a postponement was made last year on account of apprehensions of cholera.

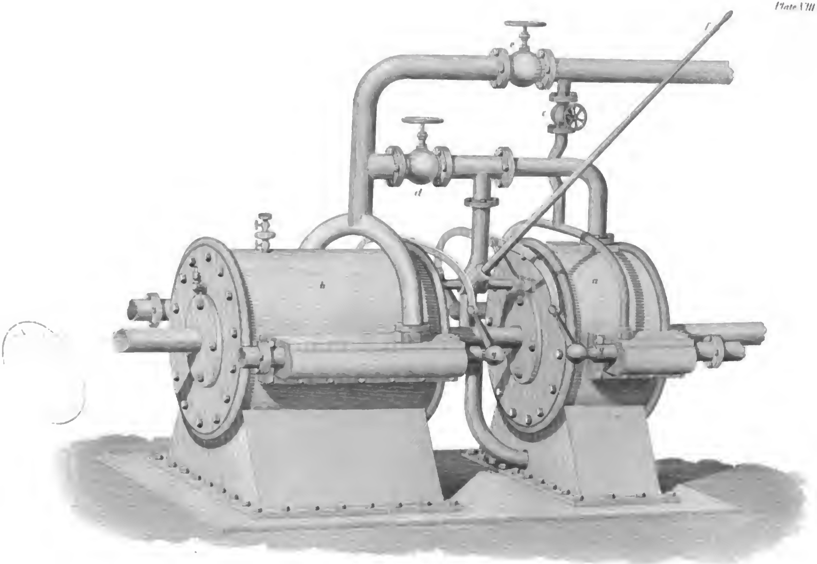
The manufacture of De Laines does not appear to have proved successful in this country, to judge from a late scrap in the Woonsocket Patriot. "A number of large mills are changing back to cotton goods."

Books were opened in Baltimore, June 8th, for subscription to the stock for the Baltimore and Liverpool Steamship Company.

The Troy propeller Eclipse burst her boiler at Chicago, June 2d. Cause, it is said, defect in the boiler. The ferryboat St. Pierre, at Montreal, met with a similar accident, May 29th, after just landing 290 passengers.

The yacht Silvia, 105 tons burden, sailed from New Rochelle, June 18th, for England, to join in the yacht-race off Cowes, to come off on the 2d of August. The Silvia was built by Geo. Steers, the builder of the yacht America, and is considered the fleetest sailer. Mr. Steers is now building a yacht of 108 tons, and larger than any vessel of the New York Yacht Club, except the Maria.

A company is announced as in process of arrangement for telegraphic communication the upper and lower parts of New York city. Ten offices are proposed in different sections, all communicating with House's office in Wall-street, and all provided with House's printing instrument. The design is to transmit brief messages for a very small sum. The local telegraph in the Metropolitan Hotel, communicating between that house and the principal office in Wall-street, is found to be of great service.



DOUBLE ROTARY ENGINE.

E. BARROWS' NEW YORK.

APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 8.—Vol. III.—AUGUST 1st, 1853.

BARROWS' DOUBLE-ACTING REVERSIBLE ROTARY STEAM-ENGINE. ARRANGED FOR WORKING STEAM EXPANSIVELY.

A rotary is universally conceded to be the most directly efficient, and the most desirable form of engine, provided such can be constructed without serious practical objections. It is a remarkable fact, that this was not only the first form in which the steam-engine appeared, but has been distinctly alluded to by the best practical writers on the steam-engine, as theoretically the most perfect plan which can be devised. The massive framings and connections, and the very considerable amount of room occupied, are objections to all the ordinary forms of engines, which are none the less real, because long use has accustomed us to their existence as necessary evils. The earlier rotaries were generally failures; but while the engineering world have contented themselves with the conclusion, that until tools, materials, and refinements of workmanship were more advanced, all projects of the kind might be laid aside as useless, tolerable authorities may be instanced as looking forward with confidence to their final success. "The Artisan Club Treatise on the Steam-Engine," edited by John Bourne, referring to this subject, states: "We are by no means of opinion that a good rotary engine will never be discovered; but, on the contrary, believe that the reciprocating engine will yet be superseded by a rotary contrivance of a far simpler kind than any one now contemplates. Time will test the justice of this opinion." Further on the distinguished author considers that "an efficient rotary must be looked for rather among dynamical than statical resources." Engines, however, which are impelled by the reaction or percussion of steam issuing through orifices at high velocity, are subject to a great loss from the friction, not of the working parts, but of the elastic fluid itself; and from evident theoretical considerations can never be fully effective, except at a certain velocity (say one-third that of the issuing jet), which economic speed must vary with every variation of the pressure in the boiler. Furthermore, this velocity must be much too great for durability and efficiency, so that except for light and very rapid motions, as for circular saws and polishing wheels, the "dynamic" engines must be considered obsolete. It remains to be seen whether among the thousand and one possible devices for obtaining a direct rotary motion from the direct pressure of the fluid, there may not be one or more which may realize all the desirable qualities without involving (as most of those yet produced have done) so much friction, complexity, and delicacy, as to prevent their use for general purposes.

There are two kinds of complexity, or rather, there are two ways in which a machine may be considered simple or complex. The first is with regard to the shape of the parts, whether plain, and consisting of simple rectangular figures, or curved, crooked, and filled with holes, notches, or protuberances. The second is with regard to the motions of the parts, whether, on the one hand, simple, smooth, regular, and capable of being varied considerably by wear or bad workmanship, without serious derangement; or whether, on the other hand, the motion be intricate, and necessarily performed with strict accuracy. It is needless to inform the practical machinist, however little his attention may have been heretofore attracted to this distinction, that the latter alone is considered objectionable. Intricately-shaped pieces of metal may look more formidable in the construction, but may often be put together and kept in order with much less labor and attention than another which would appear on the first view much simpler.

These general remarks apply with much force to the engine or engines about to be described. In complexity of form alone, including the arrangements for packing every rubbing surface, however slight the motion, the engine of Col. Barrows appears almost labyrinthically obscure, while, with reference to the motions, excepting the very slight motions of the packing pieces to fill the irregularities, nothing can well be simpler. The whole motion is represented in the accompanying diagram, in which the full line represents the regular circular motion of the steam-wheel, and the dotted line the path described by the pistons or sliding-leaves, which receive the pressure of the steam. There are no movements of the valves or cocks, except in starting, stopping, reversing, &c., and except the necessary pumps, or their equivalents, for feeding the boiler or maintaining a vacuum, these two lines represent all the motions necessary to the full administration of the whole internal or external economy of the engine.

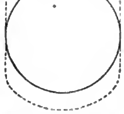


Plate VIII. is a perspective view of two cylinders or engines fixed on one shaft for expansive working of the steam. The cylinders are of equal diameter but of unequal length. The steam is first admitted to the smaller; after doing its work in which, the greater part is admitted at a lower pressure to the larger cylinder. In this respect, working the steam through two engines, it somewhat resembles the well-known Woolf engine, but with this difference, that the steam is taken from the first engine at such a point that it exerts no back pressure. This will be understood by examining Plate IX., which represents a vertical and horizontal section of the smaller engine only. The larger engine resembles this, except in having but four instead of eight pistons, or leaves, and in having no outlets for the steam at the top and bottom, as in the smaller.

c is a pedestal of cast iron on which the cylinder rests, forming the whole of the frame of the engine; *a* is the cylinder, whose inner periphery is turned perfectly true, and whose ends are closed by heads, *d d*, in each of which heads is a groove, *h h*, the form of which is best shown in fig. 1 by dotted lines, being that of a circle with segments cut off on opposite sides, leaving only two-fourths of

Its circumference. On opposite sides of the cylinder are abutments, $n\ n$, cast upon the steam-heads, $m\ m$; on either side of which abutments are quadrangular openings, $t\ t'$, $u\ u'$, connecting with the double three-way cocks, $q\ q'$. To the inside of the cylinder is fitted the steam-wheel $ee\ ee\ e'e'$. The ends of the steam-wheel are formed of two plates, ee, ee, of a diameter equal to the interior of the cylinder, and secured by bolts ii, to a ring $e'e'$ of less diameter, which forms the bottom of the channel f, in which the steam acts. Its axle j passes through boxes in the cylinder ends, packed with metallic packing, and lined with anti-friction rollers. The rollers may, no doubt, be omitted in practice, as a refinement of little use, if not positively productive of derangement. The peripheries of the two plates, ee, ee, forming the ends of the steam-wheel, are made to fit steam-tight to the interior of the cylinder, by means of metallic packing-rings let into the exterior of their flanges as represented. The abutments $n\ n$ are packed with metallic packing o to the bottom and p to the sides of the channel f; the packing-pieces o and p being dovetailed together, so that p will slide with o, but at the same time slide outwards, independently of it as they wear. The steam acts in the passage f upon 8 slides or leaves $g\ g$, which we will term pistons, which revolve with the steam-wheel, but are capable of sliding to or from the centre through slots in the ring $e'e'$. It will be seen that the sides of the channel f are formed by the plates ee, before described, so that the channel is, in fact, wholly sunk in the rim of the steam-wheel. The pistons are made a little wider than the channel, and are partially supported by shallow radial grooves on the inside of the plates ee. The pistons are packed on their edges both to the inner periphery of the cylinder and to the grooves in the sides of the channel f. This packing is shown on the right hand of Fig. 2, Plate IX. in section, the section being taken through the centre of the piston, and exhibiting the end and side packing dovetailed loosely together in the same manner as already described in the packing of the abutments. The slots through which the pistons slide are also packed, as represented in fig. 1. All the packing pieces are kept to their work by small helical springs at their backs. From the inner edge of each piston at each side, a square stud b' projects through a radial slot f', in the plates ee, and at the end of each stud is a pivot g', carrying a friction-roller. These friction-rollers travel in the grooves $h\ h$, inside the fixed cylinder head, and during the revolution of the wheel cause the pistons to alternately project and withdraw into the wheel. By the form of the groove, it will be seen that each piston will project across the channel f during two-fourths of the revolution, while, during the remaining two-fourths, it will be wholly or in part withdrawn into the interior of the wheel. At the moment of passing either abutment, $n\ n$, the outer edge of the piston will coincide with the outer surface of the ring $e'e'$, so that the packing pieces oo of the abutments have presented to them by the revolution of the steam-wheel simply a continuous cylindrical surface.

The steam-heads or cocks $m\ m$, through which the steam is admitted to the cylinder, and which supply the place of valves, valve-gear, and reversing-gear in ordinary engines, are of peculiar construction, having six ways or passages in each. There are conical seats in each to receive the plugs $q\ q'$, in which are passages to correspond with the ways in the steam-heads. The steam-pipe s has two branches leading to the two steam-heads. Of the six ways or passages in each steam-head two, $t\ t'$, are steam-passages leading from the cock-seats into the channel f, the former above and the latter below the abutment (see the right-hand side of Fig. 1, Plate IX.); $n\ n'$ are exhaust-passages leading from the cylinder to the cock-seats, the former from above and the latter from below the abutments (see left-hand side of Fig. 1, Plate IX.). In addition to the four already described, one r leads from the steam-pipe to the cock-seat, and the remaining one r, Fig. 2, Pl. IX., is a continuation of the cock-seat, provided with a flange at its extremity for connecting to the exhaust-pipe. The vertical section, Fig. 1, is taken through the steam-passages on the right side, but through the exhaust-passages on the left. The plugs $q\ q'$ have each two passages, the first k, Fig. 2, Pl. IX., being for the purpose of communication between the steam-pipe and either of the passages $t\ t'$, and admitting steam on either the upper or lower side of its corresponding abutment, the other, l, in a hollow part of the plug, being for forming a communication between the exhaust-passage r and the opposite side of the abutment to that which is in communication with the steam-pipe. The two plugs $q\ q'$ are furnished with levers (see Plate VIII.), by which they are turned to admit the steam on either side of the abutment, and allow the escape of the exhaust from the opposite side, and the levers are connected, so that both are reversed at the same instant. Whatever relation, therefore, exists between the several passages in one steam-head and cock, the opposite relation must exist between the passages in the other. In Fig. 1, Plate IX., the cock on the right-hand side of the figure is in such position, that steam is admitted through the passage t above the abutment, the passage t' being effectually closed, while in the same cock the exhaust-passage u', imperfectly represented by dotted lines as being more distant from the eye, is open, and admits the exhaust steam to escape from the lower side of the abutment into the hollow portion of the plug at its further end. In the other steam-head, the lower steam and the upper exhaust are supposed to be open, the dotted steam-passages $t\ t'$ being on this side nearer the eye than the exhaust-passages $n\ n'$ through which this section is taken.

We have been thus particular in our description of the cocks, because of their very peculiar and intricate forms, and the importance of their functions. Other devices might be substituted in large engines, if larger openings were considered desirable. It will be recollected that there is no movement of these cocks, except in reversing, all the passages being full open, and the steam exerting its full force in every possible position of the wheel. Any other point in connection with the operation of the small engine alone, not sufficiently explained, will be readily apparent by studying the drawings. The arrows indicate the movements of the steam, and also the direction in which the wheel revolves, every particle of steam expended being effective in driving the wheel, without loss by filling any cavities uselessly, as in the valve passages and clearance of every variety of reciprocating engine.

It now remains to describe the provision for rendering available some portion of the expansive power of the steam, the part yet described being equivalent only to an ordinary reciprocating engine without a cut-off. The spaces in the channel f between each piston appear as if filled with steam of full pressure, which is carried along by the revolution of the wheel, and discharged into the exhaust passage of the opposite steam-head. This would be the case but for the passages $w\ w'$, midway between the steam-heads, through which a large portion of the steam thus confined expands itself into the second or mate engine, which is of similar construction, but containing only four instead of eight pistons. The channel in which the steam works in the second engine may also be deeper, and any desired ratio may subsist between the capacities of the two engines. Suppose the boiler pressure to be 60 lbs. per square inch, and the capacity of the second engine be twice that of the first, steam from the boiler at 60 lbs. above the atmosphere, or 75 lbs. total pressure, is expanded in passing the passage w into three times its original space, two volumes going over into the second engine, while one volume remains in the first. The pressure will thus be reduced, according to the law of Boyle and Marriotte, to about $\frac{75}{3} = 25$ lbs. total, or 10 lbs. above

BARROWS' DOUBLE ACTING REVERSIBLE
ROTARY STEAM ENGINE.

Fig I

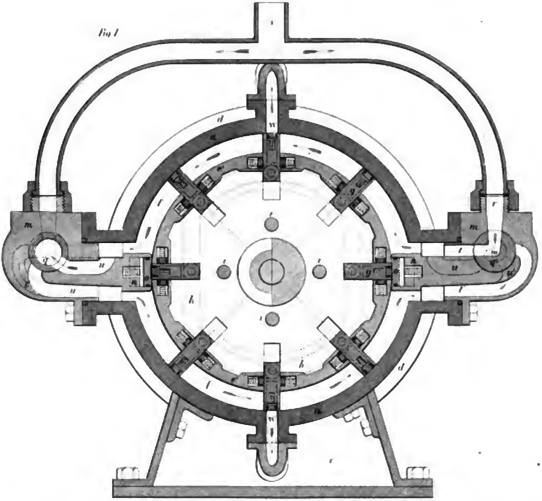
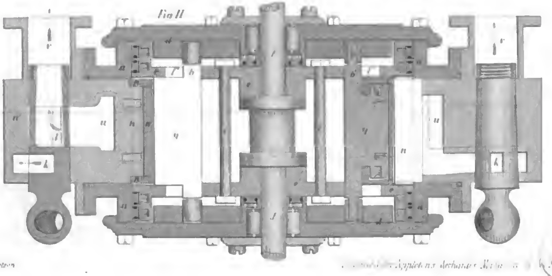


Fig II



Drawn by [illegible]

[illegible] Appleton's Mechanics' Magazine [illegible]

the atmosphere. The additional force, therefore, due to the existence of the second engine will be that of 10 lbs. per inch upon a double area, or one-third that of the first engine $[10 \times 2 = 60 \times \frac{1}{3}]$. If the engines are condensing, and exhaust into a perfect vacuum, the power of the second engine will be two-thirds that of the first $[25 \times 2 = 75 \times \frac{2}{3}]$. If the second engine be only equal in capacity to the first, the pressure on its pistons will be half the boiler pressure, or 37·5 lbs.; and the effect of the second will be one-half the first, when both exhaust into a vacuum, or a little more than one-third, when exhausting into the atmosphere $[37{\cdot}5 - 15 = 22{\cdot}5 \text{ lbs.}, 22{\cdot}5 > 60 \times \frac{1}{3}]$. Whatever the proportion, a little reflection will show that this second use of a portion of the steam is no tax upon the power of the first, but rather assists it, by leaving a smaller quantity to be expelled through the exhaust. Any one may readily calculate for himself the effect of any other ratio between the cylinders, or of any other initial pressure than 60 lbs. The inventor prefers a second cylinder of about twice the capacity of the first.

A considerable advantage to be derived under some circumstances from the existence of two engines, is the possibility of using both for a few minutes on any extraordinary occasion, under full pressure, by connecting each directly with the boiler. In Plate VIII., *a* represents the first and *b* the second engine. Under ordinary circumstances, the stop-valves *c* and *d* being open, the steam from the boiler would be admitted through *c* into *a* alone, after working through which, a portion would pass over through the stop-valve *d* into the cylinder *b*. Should occasion require an extraordinary effort, the valve *d* may be closed and *e* opened, thus shutting the communication between the engines, and opening each to the full pressure of steam from the boiler. Both might be thus worked so long as the boiler could generate a sufficient supply of steam.

Unlike many very ingenious contrivances for effecting the same object, Col. Barrows' Rotary requires no unusual tools or extraordinary skill, either in the construction, management, or repairs. A simple movement of the lever *f*, Plate VIII., stops or reverses the engine, and the manipulations required in its management, though demanding competent engineers, are certainly as simple as in any possible form of the reciprocating engine. Water in the cylinder, though some obstruction when in great quantities, is always quickly expelled through the exhaust, producing no strain of any kind on either the fixed or working parts. All these are merits readily appreciated by the practical engineer. Many inventions, very desirable and economical on paper, are rendered inexpedient by the impossibility of repairs, except in the shops where they are built, or by other practical evils arising from the intricacy, or possibly from the novelty alone of the contrivance, when placed in the care of men unaccustomed to their use.

The Inventor has constructed, at different times, two single engines on this plan, both of which are justly considered highly successful. These each have four pistons with no provision for expansion; but in other respects the latest and largest is precisely as figured in the plates. The smaller engine is now on exhibition in the Crystal Palace, the larger one is in use on a small vessel, christened the "Rotary," alluded to in the monthly notes of our last number.

The invention has been noticed by the press of this city at various times within the year past, and always quite favorably. The Scientific American presented quite a full description, illustrated, and has noticed it since on several occasions. The Journal of Commerce, of November 27th, published a communication from the inventor, giving a history of the two engines, from which we extract the following:—

"The long-standing prejudice existing against rotary engines is pretty generally known to all who have paid any attention to steam engines; as also the arguments used by most of our practical engineers and scientific gentlemen, that there could be but little or no power obtained from the rotary without a great velocity, and consequently at a great loss of steam, and that the wear would be so unequal and so difficult to be kept steam tight, and friction so great, that they could not be made practicable. But say they, we admit that the rotary motion is the most natural and most desirable. Now, if you can produce a rotary that will keep up a constant and equal pressure on the pistons, with the expansive power of steam direct, your packing so arranged as not to allow of the escape of steam, with a light amount of friction, with the whole combination so arranged as not to be subject to frequent repairs, and with the *reversible qualities* which are necessary to make it practicable, then we will admit that you have gained the long-desired point.

"My first rotary in the present form was placed on board of a little boat, which I had built for the purpose of more fully testing it. Her name was the Rotary Experiment, 36 feet long, 7 feet beam, and 10 feet across her guards, paddle-wheels 4 feet 6 inches in diameter. The engine being small was geared to the main shaft, to take the advantage of leverage, the engine making 3 revolutions to the paddle-wheels' one; the steam chamber to the engine was only 12 inches in diameter, 5 inches width, and ¾ of an inch deep; which is divided into two chambers, by means of abutments or steam heads at opposite points, through which steam is admitted and exhausted, and acts alternately on two sets of pistons, thoroughly avoiding all centre pressure, and exerting double power, and can be reversed instantaneously. Each piston presents an area of 3¾ square inches. Acting alternately on two pistons, it gives this little engine but 7½ square inches of piston surface, and that at a leverage of 5⅝ of an inch. Such is the size of the engine that propelled my Rotary Experiment on our rivers about 14 months since, her paddle-wheels making from 70 to 80 revolutions per minute. The boiler which supplied her with steam was very small, estimated to be from 2 to 3 horse power, and was supplied with cold water direct from the river. Yet we had no difficulty in keeping up a supply of steam, using about one ton of coal in 36 hours. I think no reciprocating engine of the same capacity can produce a like beneficial result from the same amount of steam. If the above points are admitted, what is there to prevent its final success? Is it more subject to repairs? That is not the case; for all the time it was in operation in my store, it was put to the severest test, by using pries and levers under the pulley, to try and stop it, and in various other ways; and from there it was removed on board of my Rotary Experiment, and used in the very roughest manner, and using nothing but salt water in my boilers for the six weeks it was on board; and for some days while in operation there was not one drop of oil used on the Rotary. Yet it seemed to wear smoother and smoother, instead of creating great friction and wearing out of order. So from the practical results of my little Rotary, which was more favorable than I had anticipated, I was induced to build a large engine and boat, of 75 feet in length, 13 feet beam, 22 feet across the guards, and 4 feet hold; paddle-wheels 8 feet 4 inches in diameter, paddles 3 feet 3 inches long and 9 inch dip, shaft 3½ inches, which runs on anti-friction rollers, similar to those used on patent sheave blocks. These proved a failure, as the rollers would cut into the boxes when under full pressure of steam, and created great friction. They were removed about three weeks since, and the common composition boxes substituted, which answer a much better purpose, as I have obtained a greater speed since, and got clear of all the old difficulties. The boiler used is similar to that of the locomotive, 8 feet long, 3 feet 8 inches wide, and 5 feet high; fire chamber, 3 feet by 4 feet 2 inches; 65 tubes, 2 inches in diameter running from the fire chamber to the back of the boiler, and returning over the top of the arch to the front of the boiler to the smoke stack. This construction of boiler is good for generating steam, where a sufficient draft is obtained; and as the natural draft was poor, I substituted a small blower. Since then I have found no difficulty in keeping up a supply of steam, with coal that will not clinker, (although I supply my boiler with cold water direct from the river.) The capacity of my Rotary will best compare with a reciprocating engine of 8⅝ inches cylinder and 39 inches stroke, my steam chamber being 30 inches in diameter, 12 inches wide, and 2¼ inches deep; the face of piston being 27 square inches, steam acting alternately (as described on the smaller engine), it gives 54 square inches for the effective pressure of steam to action, and that at a leverage of 13⅞ inches. Suppose the steam to be at 80 lbs. pressure (as my certificate allows me), 54 times 80 would show 4320 lbs steady pressure in the shaft, at a perfect leverage of 13⅞ inches. So the power of engine and speed of boat may be increased and diminished according to the pressure of steam used."

My steamboat "Rotary," of which the above is a description, has been running on our river at different times for the last three months, and was noticed by most of the papers of this city, and seen from most of our steamboats. But few are aware of the diminutive size of the engine, and the small amount of steam used to propel so large a boat. She has been seen (although at such times in rough weather) keeping pace with some boats that were three or four times her capacity.

On Tuesday, the 16th inst., we left the city with our steamboat "Rotary" for Albany, making the passage in 18 hours running time, although we had a heavy wind against us all the way. We made the passage from Albany to Troy in 48 minutes, the tide at the same being against us. At 3 o'clock we were ready to return to Albany. When I left, the George Law, a large freight and passenger boat, some 200 feet in length, and considered a fast boat for her size, was about 150 yards ahead, and all she gained on me from Troy to Albany was just 4 minutes, my boat making her passage from State-street, Troy, to State-street, Albany, in just 40 *minutes*, making 57 revolutions *per minute*. I would here mention that my engine is coupled direct to the main shaft. At 7½ o'clock P. M. we left Albany on our way for New-York, and arrived the next day about 3 o'clock P. M.—our running time from city to city being 16 hours. I feel confident that with 1½ tons of good coal, I can run my boat from this city to Albany in 14 hours; and I believe I can take one of our river boats, and put one of my rotary engines on board of her, that shall use steam at as low a pressure as required, and propel her at a gain of speed at least one quarter, and a great saving of fuel and space; while you may sit in your saloons undisturbed as when in your parlors at home, being freed from that unequal pressure and oscillating motion which cannot be overcome by the engines now in use.

This rotary that propels my steamer "Rotary" has not had the least thing done to it since it was put on board; not even a screw disturbed, and with proper attention will not need repairs for years to come; and as there are no surfaces in contact with each other, except the packing, which is metallic, it may be repaired at a trifling expense. I find she now works with less friction, if possible, and cuts off her steam closer than when first put in operation.

The boat is undoubtedly very fast for her size, a fact which is due in a great measure to her model. She is now running on a regular route between Newark and N. Bellville, N. J.

It is sufficient to say of the practical working of this engine, that up to the present time, July 20th, every detail of the engine is in perfect order. The nearest approximation to the amount of friction is obtained from the following data, furnished by the inventor and the engineer of the boat. The small engine, now in the Exhibition, requires 2 lbs. pressure to commence and maintain its motion unloaded. The boat engine requires 8 lbs. to revolve the wheels and work the pumps. This, if strictly correct, as we have every reason to believe, will compare well with the majority of reciprocating engines.

To avoid the labor of nicely fitting the packings, which are of steel, small grooves are made in their sides and filled with soft metal, which is allowed to project slightly in all directions. The packing is then forced tightly into its place, the soft metal readily adapting itself to the size of the cavity, and allowing the slight motion necessary to perform its functions.

This rotary is superior in several points to any with which we are familiar. A gentleman of our acquaintance informs us that he has collected 225 such designs. One point, of no little importance, in which this engine stands alone, is absence of injurious endwear. The packing of the ends always tends to wear unequally, by reason of the greater velocity of the parts more distant from the centre. This is avoided in the engine in question, by sinking the steam channel entirely within the rim of the steam-wheel, so that the only friction is fair against the inside of the cylindrical surface. There is in theory no necessity for heads to the cylinder at all, except for grooves to control the radial movements of the pistons.

This invention has been secured in England and France, and a patent is, we learn, about to be issued for our own country. Col. Barrows is a practical man, better known generally for his inventions of furnaces and heating apparatus, and has spent much time and money in bringing this subject before the public. His address is, Ebenezer Barrows, 228 Water-street, corner of Beekman, this city. He will promptly furnish any further information which may be desired.

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The Princeton and her Propellers.

From the Journal of the Franklin Institute.

From a late article of considerable length on the Screw Steamer Princeton, communicated to the Journal of the Franklin Institute by Mr. Chief Engineer Isherwood, U. S. N., we extract the following as among the most important points relating to the hull, rig, engines, and propeller of this very efficient naval vessel, pronounced in another paragraph "the best man-of-war steamer ever yet afloat."

In the winter of 1837, Captain John Ericsson applied his peculiar form of screw to a small boat called the *Novelty*, which was run on the canal between Manchester and London, England. The *Novelty* is *said* to have attained a speed of from 8 to 9 miles per hour; this was in the very infancy of screw propulsion, and the performance being witnessed by Capt. R. F. Stockton, U.S.N., an energetic officer of talent and fortune, he was so struck with the peculiar adaptitude of the new system of propelling for war steamers, that he had a small iron steam vessel built (called by his own name), fitted with the screw, and sent to the U. States. On returning thither himself, his representations to the U. S. government resulted in an order to construct a screw war steamer of corvette size; Ericsson, who had also come to the United States, furnished the plans of the entire machinery, and the result was the *Princeton*. This vessel was commenced at the Philadelphia navy yard, in July, 1842, and was finished and sailed in fifteen months. In 1849 she was surveyed at the Charlestown navy yard, Massachussetts, and her hull, principally built of unseasoned white oak, treenailed; being found too much decayed for repairs, the machinery was taken out and the vessel broken up.

But one alteration was made to the *Princeton*, and that was the substitution of the Stevens' for the Ericsson's screw, in March, 1845, at a cost of $9,000. The cost of breaking up the vessel was $3,145 34. These items added to the first cost, and to the repairs, makes the total cost of the vessel $323,001 77, from which must be deducted the value of the engines and shafting (used in the new vessel of the same name), and the value of the old iron boilers, and Stevens' bronze screw, and the bronze stern bearing, &c. (taken in part payment by contractors for new vessel), amounting to about $33,000, leaving the cost of the *Princeton* to the government, $290,001 77. Duration of vessel from date of completion, five years and nine months.

HULL.—With *one-third* the water, provisions, and stores expended, the displacement is, - - -	954 tons.
Corresponding to a mean draft of - - -	16 feet 1¼inch
Length of the load line from forward side of rabbet of stem to aft side of rabbet of post at the above line,	153 feet 8½ in.
Extreme breadth, - - - - -	30 "
Depth of hold, - - - - -	21 " 6 in.
Depth from mean load line to lower edge of rabbet,	14 "
Displacement in cubic feet, exclusive of keel -	32,938
Disp't in proportion to circumscrib'g parallelopipedon	·525
Displacement in proportion to cylinder, having for base the floating line - - - - -	·262
Displacement in proportion to cylinder, having for base the greatest immersed transverse section. -	·634
Centre of gravity of displacement before the middle of the length of the load line, - - -	3 feet 11½ in.
Centre of gravity of displacement below the mean load line - - - - - -	5 " 4¼ "
Area of mean load line, - - - - -	3740·8 sq. feet.
" " " in proportion to circumscribing parallelogram, - - - - -	·611
Centre of gravity of area of mean load line before the middle of the length, - - - -	2 feet 5¼ in.
Area of greatest immersed transverse section, -	338 sq. feet.
" " " " " in proportion to circumscribing parallelogram, - -	·804
Centre of gravity of area of greatest transverse section below mean load line, - - - -	8 feet 1¼ inch.
Distance of the greatest immersed transverse section before the middle of the length, - -	7 " 1½ "
Height of meta centre above the centre of displacem't,	7 "
Displacement per inch at the mean load line, -	9·17 tons.
Launching weight of hull, - - -	418 tons.

Rig.—

Surface of courses, topsails, topgallant sails, jib and spanker, - - - - -	11,752 sq. feet.
Centre of effort before the centre of displacement, -	3 feet 8½ in.
" " above the mean load line, -	58 " 3½ "
Surface of sail in proportion to area of mean load line,	3·14 to 1·00
" " " " greatest immersed transverse section, - - - -	34·92 to 1·00
Square feet of surface of sail in proportion to tons of displacement, - - - -	12·33 to 1·00

Engines.—Two semi-cylindrical, direct acting, condensing engines, with rectangular pistons, vibrating through an arc of 90°. The engines are attached direct to the screw shaft, which makes one revolution to each double stroke of the engine pistons. Each semi-cylinder is equivalent to an ordinary cylinder with a diameter of 57½ inches; stroke of piston, 3 feet; space displacement of both pistons per stroke, 108·19 cubic feet. The engines have a fixed slide cut-off valve, worked by an independent eccentric, and cutting off at one-third the stroke of piston from the commencement. The steam valve is the common three-ported slide.

Area of steam port, - - - -	108 sq. inches.
" exhaust port, - - -	162 "
Steam space between cut-off and steam valves, one end of both cylinders, - - - -	3 cubic feet.
Steam space between steam valves and pistons, one end of both cylinders, - - - -	10·36 "
Weight of engines, exclusive of screw propeller, but inclusive of shafting, &c., - - -	86·34 tons.

Coal Bunkers.—

The coal bunkers are of iron and weigh -	61 tons.

This vessel was originally fitted with the Ericsson screw, as shown in fig. 1. This screw was placed in the stern of the vessel, between the sternpost and rudder post, and was composed of a bronze hub, arms, and drum, cast in one piece; on the drum were riveted 6 cast bronze arms. The screw was secured to the shaft (which was made tapering) by 6 long steel feathers, let half into the hub, and half into the shaft, and by a strong steel key through hub and shaft, to back against.

The thickness of the blades at the drum was only 1½ inch.—The proportions of the screw were those generally employed by Ericsson, viz.: six arms inside, and six blades outside the drum, the drum being placed at nearly half the distance from periphery of hub to periphery of screw. The arms and drum were of uniform length, measured on the axis of the screw, and the arms were equal in the aggregate to ·343 the pitch. The blades overhang the drum, from which they curve out; they are equal in the aggregate to 7-10ths the pitch. The pitch is uniform for the entire screw surface, and is equal to 2½ times the diameter of the screw. The following are the dimensions:

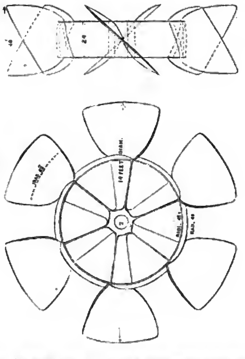
Fig. 1.

Diameter of hub, - - - - -	1 foot 6 in.
" drum, - - - - -	8 feet.
" screw, - - - - -	14 "
Number of arms, - - - - -	6.
" blades, - - - - -	6.
Length of the arms and drum in direction of axis,	2 feet.
" screw at 5 feet 6 inches radius in direction of axis, - -	4 " 1 inch.
" " periphery " - -	4 " 1 "
Pitch of the screw, - - - -	35 "
Angle of the blade at periphery from a line at right angles to axis, - - - -	38° 31′
Helicoidal area of the 6 arms, - 43·886 sq. ft.	
" " " 6 blades, - 120·536 "	
Total helicoidal area of the screw, - -	163·422 sq. feet.
Projected area of 6 arms on a plane at right angles to axis, 16·634 sq. ft.	
" " 6 blades " - 68·384 "	
Total projected area of screw on a plane at right angles to axis, - - - - -	85·018 sq. feet.
Mean fraction of pitch used, - - -	·559
Weight of the screw, - - -	12,000 pounds.

Stevens' Screw.—Commodore Stockton becoming dissatisfied with the performance of the Ericsson screw, had it taken off at the Norfolk Navy Yard in March, 1845, and a screw (fig. 2) designed by Stevens, of Hoboken, with the following dimensions, substituted for it. This screw was also of bronze, and of uniform pitch for the entire screw surface; thickness of blades at hub 4 inches. Each blade and the one-sixth part of the hub were cast in one piece, and the whole riveted together. This screw was secured on the shaft in the same manner as Ericsson's.

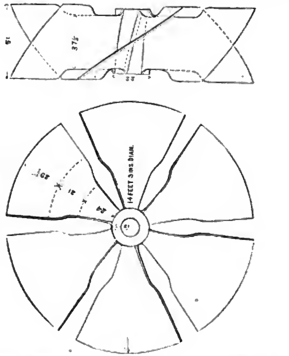
Fig. 2.

Diameter of hub, - - - - -	1 foot 10 in.
" screw, - - - - -	14 " 3 "
Number of blades - - - -	6.
Length of screw on hub in direction of axis, -	3 feet 11 inch.
" " at 3 feet radius in direction of axis,	3 " 11 "
" " 4ft. 9in. " " "	4 " 3 "
" " periphery " "	4 " 3 "
Pitch of the screw, - - - -	32·44 feet.
Angle of the blades at periphery from a line at right angles to axis, - - - -	35° 56′.

Helleoidal area of the 6 blades,		176·718 sq. feet.
Projected " "	on a plane at "	113·515 "
Mean fraction of pitch used,		·721.
Weight of the screw,		15,970 pounds.

EXPERIMENT TO TEST THE RELATIVE EFFICIENCY OF THE ERICSSON AND STEVENS' SCREWS.

ERICSSON SCREW.—In order to compare the propelling values of the two screws, their performances were accurately ascertained in smooth water, by running the vessels forward and back over the same distance, making six runs in all with each screw, at a measured statute mile of 5,280 feet, at Norfolk, Va. The Ericsson screw was experimented with on the 4th of March, 1845, the draft of the vessel being 15 feet 7 inches forward, and 18 feet 8 inches aft, or a mean draft of 17 feet 1½ inch. The course run was N.W. ¼W. and S. E. ¼ E. The water was perfectly smooth, and there was a light breeze from the eastward; topgallant and royal yards crossed. The times given were taken on deck by a stop watch.—The revolutions of the screw were counted in the engine room. The mile was run three times in each direction.

COURSE, N. W. ¼ W.						COURSE, S. E. ¼ E.					
Time of running each mile, in minutes and seconds.	Steam pressure in boiler in pounds per sq. in. above atmosphere.	Propor. of throttle open	Steam cut-off, at from commencement of stroke of piston.	Mean back pressure in the two condensers in pounds per sq. inch	Number of revolutions of the screw made in running each mile.	Time of running each mile, in min. and sec.	Steam pressure in boiler in pounds per sq. in. above atmosphere.	Propor. of throttle open	Steam cut-off, at from commencement of stroke of piston.	Mean back pressure in the two condensers in pounds per sq. inch.	Number of revolutions of the screw made in running each mile.
6' 0"	17	[illegible]	[illegible]	1·7	174	5' 7"	18	[illegible]	[illegible]	1·7	152
5 50	18	[illegible]	[illegible]	1·7	175	5 6	18	[illegible]	[illegible]	1·7	158
5 42	18	[illegible]	[illegible]	1·7	171	5 7	18	[illegible]	[illegible]	1·7	155

Total time of running 6 miles,	32 min. 52 sec.
Total number of revolutions of the screw made in running 6 miles,	985.
Speed of the vessel per hour in statute miles of 5280 ft.	10·95385
Revolutions of the screw per minute,	29·9625
Slip of the screw in per centums of its speed	8·107
Mean effective pressure per square inch of pistons,	17·7 pounds.
Horses power developed by the engines,	500·898

STEVENS' SCREW.—The Ericsson screw having been removed, and the Stevens' substituted, a trial was made with it March 22d, 1845, between the same points as with the Ericsson. The draft of the vessel, condition of rigging, &c., were the same as before; but the water was not quite as smooth, and there was a topgallant breeze from the westward. In this experiment the mile was not run three times in each direction, on account of vessels getting in the way; it was run twice against and four times with the wind. In calculating the results, however, I have corrected for this by averaging the mean of the two runs against the wind with the mean of the four runs with the wind, and taking this average as the true performance uninfluenced by wind or current. After the trial the Stevens' screw was permanently retained in the vessel.

COURSE, N. W. ¼ W.						COURSE, S. E. ¼ E.					
Time of running each mile, in minutes and seconds.	Steam pressure in boiler in pounds per sq. in. above atmosphere.	Propor. of throttle open	Steam cut-off at from commencement of stroke of piston.	Mean back pressure in the two condensers in pounds per sq. in.	Number of revolutions of the screw made in running each mile.	Time of running each mile in min. and sec.	Steam pres re in boilers in pounds per sq. in. above atmosphere.	Propor. of throttle open	Steam cut-off at from commencement of stroke of piston.	Mean back pressure in the two condensers in pounds per sq. in.	Number of revolutions of the screw made in running each mile.
5' 4"	18	[illegible]	[illegible]	1·45	182.4	5' 0"	18	[illegible]	[illegible]	1·45	179
5 16	18	[illegible]	[illegible]	1·45	189·6	4 50	18	[illegible]	[illegible]	1·45	172
						4 48	18	[illegible]	[illegible]	1·45	167·5
						4 40	18	[illegible]	[illegible]	1·65	164 6

Average time of running one mile.	5 seconds.
" number of revolutions of the screw made in running one mile	178·858
Speed of the vessel per hour in statute miles of 5280 feet,	12
Revolutions of the screw per minute,	35·6776
Slip of the screw in per centums of its speed,	8·769
Mean effective pressure per square inch of pistons,	18 pounds.
Horses power developed by the engines,	606·402.

COMPARISON OF THE RESULTS.—Taking the horses power developed by the engines as the expression for the powers, and the cubes of the speeds as the measure of their useful effects, we shall obtain the following results, viz:

	Powers.	Speeds.
Ericsson screw,	500·898 or 1·00000	$10·95385^3$ or 1·00000
Stevens' "	606·502 or 1·21064	$12·00000^3$ or 1.31473

$$\text{and } \frac{1·31473}{1·21064} = 1·086$$

That is to say, the Stevens screw was more economically efficient than the Ericsson in the proportion of 1·086 to 1·000. Now, as the loss of useful effect by slip was in a slight degree greater with the Stevens than with the Ericsson screw, the economical superiority of the former must have arisen from its less friction on the water, owing to its greatly less surface, if the surface of the drum be included. I have been informed by the engineers on these occasions, that during the experiment with the Ericsson screw, one corner of one of the blades was considerably bent over by having previously struck some floating body; likewise, that the boilers foamed considerably, the consequences of which would be a lower cylinder pressure proportionally to the boiler pressure, and a greater load of injection water thrown upon the air pumps to maintain the same back pressure in the condensers, while the back pressure in the cylinder would be higher proportionally to the condenser back pressure. In the calculation of the powers developed by the engines in the experiments with the two screws, the same difference is taken between the boiler and cylinder pressures, and between the condenser and cylinder back pressures. But even if a slight correction be made in favor of the Ericsson screw from these causes, there yet remains a decided difference in favor of the Stevens' screw.

It will be observed that in the table of the performance with the Ericsson screw, the slip is much greater than in the tables of the performance with the Stevens screw; but in the former case the steaming was done on the Northern United States coast in the winter months, and consequently in much heavier weather than in the latter case, where the steaming was principally done in the Mediterranean Sea and Gulf of Mexico during the summer months, and very fine weather. In ordinary sea-going weather the performance of the Stevens screw must have been somewhat superior, as its less pitch and greater diameter, with greater length in axis, must have given less slip, and the omission of the drum less friction, as the area of its two sides was considerable, besides the resistance of its cutting edge. I am also of opinion that when in operation, the pitch of the Ericsson screw became really greater than it was when at rest, from the springing or yielding back of the front edge of the thin overhanging blade, which would have made the real slip greater than given in the tables. The blades of the Stevens screw were heavier and stiffer, and their front edges better supported from the hub. The data of the foregoing experiment is taken from the official report, and is the only correct one I have seen.

THE SCREW AS AN AUXILIARY.—In 1845, May 6th, the Princeton, cruising in company with the U. S. first class corvettes St. Marys and Saratoga, and the brig Porpoise, the former accounted an extraordinary fast sailer, made a trial for the purpose of ascertaining what pressure of steam, what number of revolutions of the screw, and what weight of coal would be required in addition to her sails, to beat her consorts.

At 9 A. M. started fires in the furnaces and signalled the squadron to make sail. The St. Marys and Saratoga set royals and steering sails alow and aloft, both sides. At 10 h. 30 m., A. M., all the squadron were ahead of the Princeton; at 10 h. 40 m. started the engines of the Princeton; at 11 h. A. M. passed the Saratoga with 8 lbs. of steam, screw making 18 revolutions per minute, overhauling the St. Marys, she being four miles ahead; at 12 M. the St Marys was between two and three miles ahead; at 1 h. 30 m., P. M., the Princeton hauled up to speak a ship about six miles distant; overhauled and spoke her, then kept away for the squadron, setting all the port steering sails. At 7 h. 30 m. P. M. passed the Saratoga and Porpoise, they being under a press of sail; at 8 h. 30m. P. M. passed the St. Marys, she having shortened sail.

The following table gives the absolute performance of the Princeton during this trial, the engines being much throttled:

Hours.	Steam pressure in boiler in lbs. per sq. inch, above atmosphere.	Revolutions of the screw per minute.	Pounds of anthracite coal burned per hour.	Speed of the vessel pr. hr. in knots of 6082½ feet.	Slip of the screw in per cent. of its speed.
11	8	18	4000	5½	0·17
12	5	17¾	2000	7	25·00
1	5	18½	900	7	18·24
2	5	19	900	7	15·14
3	10	26	900	5	39·90
4	6	21	900	5	25·59
5	5	21	276	8	25·00
6	5	20	276	8	25·00
7	13	24	400	8	4·17
8	8	18½	400	8	35·14
9	5	19	none	7	15·11
10	1	15	none	5	4·17
Means	6¼	19·71	912½	6·73	0·42

The above trial shows that from 9 A.M., when the engines were started, the consumption of coal was 4 tons and 1992 pounds up to 10 P.M. When the fires were drawn, by which, with the aid of her sails, the Princeton was enabled to beat the squadron, the speed of the screw was on an average the same as the speed of the vessel, but, (owing to the following current in the wake of the vessel) it was probably giving a considerable propulsive effect.

On May 8th, 1845, a trial was made to ascertain whether the Princeton, under sail, would, with the aid of her steam, beat the other ships of the squadron, and whether she could tow the brig Porpoise as fast as the others could sail, and at what consumption of fuel; and to determine, also, whether the St. Marys or Saratoga was the fastest sailer, under the circumstances, there being a good royal breeze and smooth water; course steered, W. by N. ½ N.; wind, North.

At 11 o'clock, A. M., the St. Marys and Saratoga were abeam of each other; they made sail to royals and flying jib, starboard topmast and topgallant steering sails; the Porpoise being a mile ahead and under all sail. The other ships being abeam of each other, were ordered to make all sail and proceed to Galveston, Texas, (about 650 miles distant), as soon as possible. The Princeton remained one mile behind the squadron, when she made sail, and with 10 pounds of steam, 17½ revolutions of the screw per minute, and 900 pounds of coal per hour, easily beat them all; speed, 7 knots per hour; slip of screw, 25 per centum. On passing the Porpoise, she took a tow-line from that vessel, and commenced the second trial of speed with the other ships.

The Princeton took the Porpoise in tow at 12 hs. 30m. P. M., the Princeton being under topgallant sails, starboard fore topmast, and fore and main topgallant studding sails; the Porpoise was under same sail. The St. Marys was three miles ahead, and the Saratoga one mile and a half ahead. At 1 h. 50m. P. M. the Princeton was abeam the Saratoga; at 3 hs. 35 m. P. M. the Princeton was abeam the St. Marys, the Saratoga being 3 miles astern and a mile and a half to leeward. At sundown the St. Marys was about five miles distant on the lee quarter; the Saratoga about nine miles distant; the St. Marys about four miles ahead of the Saratoga. At daylight the St. Marys was eight miles distant astern, the Saratoga not in sight. At noon the St. Marys was twelve miles distant; at sundown out of sight. The mean performance during the towing of the Porpoise was as follows, viz.: steam pressure in boilers, 10·3 pounds per square inch above atmosphere; revolutions of the screw per minute 27·6; pounds of anthracite coal consumed per hour, 1656; speed of vessel per hour, 8·847 knots; slip of the screw, 0·36 per cent.; maximum speed while towing, 10 knots; minimum speed while towing, 8 knots per hour.

On the 17th of June, 1846, a short race was tried between the Princeton and the U. S. brig Somers, a vessel considered to be a very fast sailer. The brig was under all sail, from royals to courses; the Princeton was under similar sail, except topgallants, royals and flying jib. Both vessels were closehauled, and standing on the same tack, separated by only a few hundred yards; the sea was perfectly smooth, and the wind a fine-working topgallant breeze.

After speaking the brig, she stood off under all sail; the Princeton then went off, set topgallant sail, and stood after her; by this time the brig was about 400 yards ahead; in fifteen minutes the vessels were square abreast, the Princeton shooting ahead fast, when the race was discontinued, and the Princeton hauled up to cruise. During the race the Princeton used the centre boiler only, there being neither steam nor fires on the two wing boilers; the steam pressure was 6 pounds per square inch in the boilers, cut-off at one-third stroke from commencement; throttle 1-32d open; revolutions of the screw per minute, 17. Speed of the Princeton during the race 8½ knots per hour; during the last few minutes she was gaining on the brig at the rate of about 100 feet per minute. Draft of Princeton during race, 15 feet 4 inches forward, and 18 feet 8 ins. aft; slip of the screw, 60·85 per centum; consuming at the rate of 400 pounds of anthracite per hour.

The screw, as an auxiliary, proved exceedingly efficient when the Princeton acted as a blockading vessel off the port of Vera Cruz during the Mexican war. While thus employed, she would lay off and on some six miles distant from the city, under easy sail, with the fires banked in the furnaces of the centre boiler only, the steam stop-valves being closed; with the wing boilers, about 6 lbs of steam was kept on. When a vessel was descried, the fires in the centre boiler were spread, fresh coal thrown on, and the fan blast started; in fifteen minutes the generation of steam would allow the use of the engines, and by the addition of a slight power from the screw to the sails, the speed would become sufficient to overhaul any vessel. In a calm or in a very light head wind, the steam from the centre boiler only would supply the engines with 12 lbs. boiler pressure for 16½ revolutions of the screw; throttle, 1-16th open; cut-off, one-third stroke from commencement; back pressure in condenser, 3·2 lbs. per square inch; speed of vessel, 3¼ knots per hour; consumption of anthracite coal, 700 lbs. per hour, with the fan blast driven violently. During sixteen successive days the fires were thus kept banked on the centre boiler, spreading and using them occasionally when a chase hove in sight; there was consumed a total of 32,960 lbs. of anthracite, or 2060 pounds per 24 hours.

Under the above circumstances, in the month of June, 1846, off Vera Cruz, the temperature of the wing boilers from radiation and leakage through the stop valves from the centre boiler, was 160° F. and 140° F.; temperature of coal bunkers immediately over boilers, 104° F.; temperature of engine room at 10 feet from front of boilers, 115° F.; temperature on deck averaged 90° F.; of water, 80° F. The boilers were covered with one thickness of felt, on which was placed a sheet-iron casing, over which came a wooden casing, covered in turn by a last one of sheet iron. The sides of the wing boilers formed the sides of the bunker, and the coal was thrown against them.

THE PRINCETON WITHOUT STEAM, AS A SAILING VESSEL ONLY.—The Princeton was fitted with a simple clutch coupling, which, by a lever, could be thrown in or out; when out, the screw revolved by the pressure of the water against it, caused by the progress of the vessel, and opposed much less resistance to the speed of the vessel when under sail alone than if it had been dragged in a fixed position. The Princeton frequently sailed in this manner, and the following table gives the performance:

Performance of the U. S. screw steamship Princeton under sail alone, with the screw uncoupled, and revolving in the water by the progress of the vessel, embracing all the sailing found recorded in the logs at the Navy Department.

Number of hours.	Speed of the vessel per hr. in knots of 6082½ feet.	Wind.	
		Direction.	Kind.
168	3·964	Forward the beam.	Light breeze.
99	5·090	" "	Moderate "
42	5·454	" "	Fresh "
242	3·265	Abeam.	Light "
211	5·794	"	Moderate "
267	6·345	"	Fresh "
153	4·666	Aft the beam.	Light "
143	6·431	"	Moderate "
24	7·417	"	Fresh "
Mean speed under sail alone.	5·125		

The above table sufficiently explains itself, and it is only necessary to add that the maximum speeds under sail alone were as follows, viz.: 212 geographical miles made in 24 hours during Aug. 3d, 1845, or 8·833 knots per hour. Course of vessel, S. W., wind, E. and moderate, with a smooth sea and all sail set.

During 12 hours of July 25, 1847, made 122 geographical miles, or 10 and 1-6th knots per hour. Course of vessel, E. by S.; wind, a fresh breeze from southward and westward, with smooth sea, and all sail set.

During the 24 hours of July 29, 1847, made 221 geographical miles, or 9·21 knots per hour. Course of vessel, direction and strength of wind, sail, sea, &c., same as on the 25th inst., immediately preceding.

When the vessel was under sail alone, the screw being uncoupled and revolving by the pressure of the water, its revolutions, compared to the speed of the vessel, were, for a mean of several thousand observations, as follows, viz.:

The Ericsson screw made 1·9700 revolutions per minute for each knot per hour of the vessel's speed. The Stevens screw made 2·2934revolutions per minute for each knot per hour of the vessel's speed. Per unit of vessel's speed, therefore, the revolutions of the Ericsson and Stevens screws were in the ratio of 1·0000 to 1·1642. The pitches of these screws were in the ratio of 1·0789 to 1·0000, or nearly in the inverse ratio of their revolutions.

The screws would not revolve with a less speed of vessel than two knots per hour, but the ratio of their revolutions to the speed of the vessel was sensibly the same, whether that speed was 3 knots or 10 knots per hour.

Taking the average speed of the vessel, under sail alone, at 5·125 knots per hour, the revolutions of the Ericsson screw would be 10·0963 per minute, making its speed 3·486 knots per hour, at which rate the speed of the vessel would exceed it by 1·639 knots per hour, or the speed of the vessel would be greater than that of the screw by 47·00 per centum of the latter.

Taking the speed of the vessel at the same, 5·125 knots per hour, the revolutions of the Stevens screw would be 11·7537 per minute, making its speed 3·761 knots per hour, at which rate the speed of the vessel would exceed it by 1·364 knots per hour, or the speed of the vessel would be greater than that of the screw by 36·27 per centum of the latter.

It must, however, be considered that by the passage of the vessel through the water there is generated a following current of considerable speed, and that the speed of the screw under the above circumstances must be compared, not with the speed of the vessel through the water, but with that speed less the speed of the following current. The speed of this following current it is impossible to determine; but with hulls of good model at medium speeds, it may be estimated at about one-fifth the speed of vessel. If, therefore, we make a deduction of one knot from the speed of vessel, (5·125 knots per hour,) it leaves a speed of 4·125 knots of vessel to be compared with a speed of Ericsson's screw of 3·486 knots per hour, and of Stevens' screw of 3·761 knots her hour; on which assumption the retardation of the vessel's speed would be equal to the effect of a power required to drag the Ericsson screw (not revolving) through the water at a rate of 0·639 knots per hour, and the Stevens screw at a rate of 0·364 knots per hour. The resistance of the screw thus dragged would not equal that of a disk of the same area, inasmuch as the screw surface is not placed at right angles, but obliquely to the direction of motion; and as the effect of power on speed is as the cube root of that power, it will be perceived that the drag of the screw, or the retardation of the vessel's speed by it, must be very little indeed, probably in the majority of cases not sensible to the log. In confirmation of this result, I find in "Bourne's Treatise on the Screw Propeller," page 142, where the conclusions of the French experimenters on the screw vessel Pelican are cited, the following recommendations, viz.: "but in the case of merchant vessels with auxiliary power, they recommend that the screw shall be made merely capable of revolving freely, when disengaged from the engine, in the manner of a patent log. A screw thus fitted will, they say, offer scarcely any obstruction to the progress of a vessel under sail, while it will possess advantages in strength and simplicity, such as would not be otherwise attained." In the last and most perfect screw vessels of the French navy, as the Napoleon for instance, a screw of four blades is used, incapable of being hoisted out, as in the British navy, where two-bladed screws are wholly used, this number of blades being imperative where the screw is to be hoisted out. In the Napoleon the screw is simply uncoupled as in the Princeton, when it is desired to navigate the vessel with sails alone.

In addition to the mere drag of the screw just stated, there is a further retardation of the vessel's speed due to what is usually termed the screw's friction on the water; this is probably greater than the former. In the absence of all exact experiment, it is impossible to determine the value of these retardations, but I am persuaded it does not exceed one-tenth the vessel's speed; that is to say, a vessel which, disencumbered from the screw, would make 10 knots under sail, would make 9 knots dragging it.

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Rise and Fall of Lake Ontario.

From the Merchants' Magazine.

During a geological tour in the district of country lying between that lake and the river Attawa, I selected a place near the northern shore of the lake for a lakeometer, with a view of determining whether the rise and fall of the great lakes are periodic or occasional. The place selected is Gull Island, between Port Hope and Cobourg, about two miles from the northern shore of the lake. In the early settlement of the country this island had a surface of about two acres more or less, but, in the process of time, became (in high water) a sunken reef, and the inhabitants entertained the opinion that the island had settled. An examination of the reef and the northern shore of the lake satisfied me that the island had not settled down, but had been decapitated by the ice and wind. The island consists of bituminous fossiliferous limestone, in horizontal strata from one to two feet in thickness, intersected by vertical seams, east and west and north and south. During high water, in cold weather, the ice formed over the surface, and remained in contact with the rock, and when high winds lifted up the ice, and floated it away, it carried the thin strata of rock with it, and when the ice melted, dropped the rock in deep water. The same process of removing the rocks is still going on. In this way Gull Island has become a reef. The limestone is so highly bituminous that the lime-burners require but little fuel to produce calcination. The lime, after being burned, is found to contain lumps of what the lime-burners term "fire stone," a stone that undergoes no change by the heat. This bituminous property seems to have resulted from volcanic action. This portion of Lake Ontario is subject to submarine convulsions, during which the waters of the lake ebb and flow every ten minutes. At Port Hope, Coburg, Grafton and Colborne, the water of the lake recedes suddenly and leaves the harbors bare, and then returns with a violent roar and invades the land. I have recorded three of these convulsions, one on the 20th of September, 1845; another on the 8th of January, 1847, and another on the 5th of July, 1850. That of September, 1845, gave birth to a most terrific lightning storm, which traversed the whole width of the lake northeasterly, and the wilderness between Lakes Ontario and Champlain; it was accompanied by a tornado that mowed down the forest as a mower mows down the grass. That of the 5th of July, 1850, created a terrific water-spout, which was broken by a thunder-bolt, the electric energies of which also came from beneath the bottom of the lake. As soon as the lightning had finished this work it formed a cloud, which at once divided, one part following the water to Quebec, and the other crossed the lake and passed over the land towards Albany, and in its course discharged so much water as to raise the Canada creek so suddenly that the bridge crossed by the Schenectady and Utica Railway was carried away, and the trains were plunged into the water before the conductor was aware of the destruction of the bridge. I mention these facts as connected with the rise and fall of the water of that lake. On the 25th of September, 1841, the waters of Lake Ontario fell 14 inches in thirty-six hours, and did not rise again during the residue of the year. This vast quantity of water could not have been discharged by the River St. Lawrence during that time, and that river is the only known outlet of the lake. Ontario is a very deep lake, and from the mouth of Black River to the opposite shore the lake is underlaid by bituminous fossiliferous limestone, and recently that strata on the Black River and its tributaries, at Watertown and Lowville, was severely shaken by an earthquake. This section of the lake produces the most fearful lightning storms, one of which visited the county of Oswego on the 10th of February, 1851, while three feet of snow lay upon the ground, and what is wonderful, the temperature of the air, a few hours before the storm broke forth, was seven degrees below zero.

The waters of the great lakes, in their course to the ocean, describe a curve on the sphere of the earth, rising in lat. 50°, and discharging in the Gulf of the St. Lawrence in the same latitude. Between Lake Superior and the Mississippi an immense spring divides its waters between the lake and the river, a portion running each way. In very high water further down, the waters of Lake Huron and the tributaries of the Mississippi mingle. The Falls of Niagara, on the Niagara River, which connects Lake Erie with Lake Ontario, at present present a formidable barrier, but some convulsion of nature may break down this barrier; in that case, Lake Erie, which now covers a large surface, would become a river. I have spent much time in examining these falls and the country around them. At low water, when the wind was blowing up Lake Erie, I examined the strata upon which the rock composing the

Falls rests; it is a red and green shale, like that which forms the cliffs of Niagara River at Lewistown and Queenstown. I also examined the strata in the deep borings for salt water at St. Catharine's, near the edge of the Welland Canal, and found the red and green strata as at Lewiston and the Falls. The water which falls over the rock precipices at each side of Goat Island, and known as the Horse Shoe and the American Fall, descend into immense chasms excavated by the water in this red and green shale, which is soft. During strong easterly wind and low water, Lake Erie has failed to supply water to the Great Western Canal, and boats at the western end of the canal have occasionally been put to great inconvenience on account of this low water. There may come a time when this difficulty may increase and become more permanent, for there is a mystery about the rise and fall of the waters of these lakes which the greater or lesser amount of rain does not account for. I have made both minute and extensive examinations of the country to the east and south of Lake Ontario, north of the water shed which divides the waters of the Susquehannah from those of the St. Lawrence. One of the small lakes of Preble during high water discharges its waters into the tributaries of the St. Lawrence, and of the Susquehannah at the same time. The chain of lakes, commencing with Canandaigua, Crooked, Seneca, Cayuga, Beaver, Skeneateles, Cross, Owasco, Onondaga, the eastern lakes of Manlius and Oneida, discharge their surplus waters into Lake Ontario, through Oswego River: all have surfaces of more than one hundred feet elevation above that of Lake Ontario, and some of them are of equal depth. From an examination of some of these lakes, I am satisfied that what now forms the surface of the bottom once formed the surface of the ground. In connection with the surface examinations, I have examined the deep shafts sunk in that district of country for the purpose of obtaining salt water. At Lockpit, on the Erie Canal, between Montezuma and Clyde, a shaft was sunk to the depth of four hundred feet, and water as dense as the water of the Dead Sea obtained. In the sinking of this shaft the proprietor preserved, for my examination, specimens of all the strata passed through. In sinking the shaft the augur fell thirteen feet, having met with a subterranean stream, the current of which was so strong as to cause a vibration of the stem of the drill. This well discharged the water over the top occasionally, attended by a loud roaring, what the workmen called blowing. A pump was placed in the shaft, but which, on being worked hard, became clogged with crystals of selenite, formed instantly by the mingling of two veins of water, which brought the combination to the point of saturation. I have several of these crystals, as well as a quantity of the water, in my cabinet. The crystals are eight-sided flattened prisms—perfectly transparent and of shining surface, but when calcined become opaque, and discover the most minute laminæ, which can be separated like the sheets of a quire of the finest paper. These crystals present a beautiful page in the great volume of nature.

The brine of this well is of such great specific gravity that 18 gallons will make a bushel of salt, but it contains so great a portion of the chlorides of calcium and magnesium as to cause it to deliquesce. At Montezuma a shaft was sunk to the depth of 604 feet, and water as dense as that at Lockpit obtained, and so powerful was the current at that depth that the water rose ten feet above the surface of the ground, and overflowed the low grounds for a great distance. The weather being then warm and dry, it crystallized on the surface, forming a large salt field. At Syracuse, Salina, and Liverpool, I also examined the deep borings for salt water, and Mr. Disbrow, in sinking a deep salt-well at Little Sodus Bay, near the shore of Lake Ontario, reported to me the strata passed as he progressed downward. This well was sunk to the depth of 316 feet. I have thus stated some few facts connected with my examinations of the country around Lake Ontario, as connected with the rise and fall of that lake. The great specific gravity of the water in the deep wells at Montezuma and Lockpit, as well as that of the deep wells at St. Catharine's, on the Welland Canal, show that the under strata are easily dissolved. I have in my collection water of the Dead Sea, or Lake Sodom, taken from that lake in January, 1851, by Fisher Howe, Esq., of Brooklyn, and it closely resembles the waters of Lockpit and Montezuma; and I recently sent samples of the three brines to Professor Cook, of Albany, to be analyzed, and deposited in the state cabinet of natural history, with other brines obtained by me from various places on this continent.

The record of observations furnished by Capt. Spencer cover seven years, and I now add those made on Gull Island by Mr. Ousten, the keeper of the light for the years 1840, 1841, 1842, 1843, 1844, 1845, and also 1846. The two will cover thirteen consecutive years. The British government constructed a lighthouse upon Gull Island—it is a hollow column built of stone. In this hollow column the water rises and falls like the water in a well, and the measure of the rise and fall of the lake was taken regularly within this hollow column, and is what I term a lakeometer:

	Ft.	In.		Ft.	In.
1840, June 29 - - - -	2	10	1843, May 12 - - - -	1	9
" Dec. 6 - - - -	0	9	" Dec. 9 - - - -	0	8
1841, April 15 - - - -	1	6	1844, April 1 - - - -	1	2
" Sept. 25, fell 14 in. in 36 hours	0	4	" May 3 - - - -	2	0
" Dec. 7 - - - -	0	6	" Sept. 23 - - - -	0	9
1842, Mar. 24 - - - -	1	2	" Dec. 6 - - - -	0	4
" June 9 - - - -	1	6	1845, Mar. 24 - - - -	1	2
" Dec. 6 - - - -	0	8	" May 12 - - - -	2	2
1843, April 15 - - - -	0	8	" Sept. 5 - - - -	1	2

Mr. Ousten remarks, in his official report to me, that a strong westerly wind blowing for a long time creates a current up the lake. In a letter addressed to me by Mr. Ousten, dated Dec. 15th, 1846, he says: "The lake commenced rising in October, and still continued on the rise when the light was discontinued, December 6th, at the close of navigation. In August, 1846, for the first since I had charge of the light, I could walk around the tower, the rock upon which it stands being perfectly dry."

The lowest stage of water recorded was September 25, 1841, at the time the lake fell fourteen inches in thirty-six hours; and the highest, on the 29th of June, 1840, two feet ten inches. The measure is not given in August, 1846, as the water did not rise above the rock on which the lighthouse is placed. Of course it was lower than in 1841.

The observations made by Mr. Ousten show that the rise and fall of the lake is not periodic, once in seven years, as many have supposed, but is occasional.

At the last session of the legislature of the State of New-York, an act was passed appropriating one hundred thousand dollars to defray the expense of lowering the surface of the lakes tributary to the Oswego, which lie west of the outlet of Seneca River, by which means the Cayuga and Montezuma marshes, which I denominate the New-York Everglades, will be drained, the health of the inhabitants of that district promoted, and one hundred thousand acres of drowned lands, now a nuisance, made the richest and most productive lands of the State.

The Cratean lakes of Manlius, which are tributary to Lake Ontario, are, no doubt, of volcanic origin; in the neighborhood they are called "the green lakes." One of these is on the top of a hill. The banks of the upper lake, and the lake itself, are in the form of a teacup. The banks are two hundred feet high, and the water from three to four hundred feet deep. The water appears of a deep green, but on being taken up in a glass is found to be perfectly transparent. Trees and limbs which fall into the water, in a short time become incrusted; this incrustation is of a bright green color, and when exposed to the air becomes hard. Timber thus coated, when it decays, leaves the covering in the shape of hollow tubes. Wood soaked in the lake for some months, on being dried and burned, gives out a strong smell of sulphur. I found, on striking the surface of the lake with a pole, that large bubbles were made, and as these floated towards the shore, over the white rock that sloped towards the lake, so that the sun's rays were brought to a focus, a five-pointed star was produced. A farmer who resides near "the lower lake," informed me that one afternoon, while ploughing near the shore of the lake, he heard a sudden rush of water behind him; on turning around and seeing the lake rising over the land, he fled with his team, but the water soon returned to its basin. The "lower lake" has low banks, which appear to have sunk down: it receives the surplus water of the "upper lake" through a chasm in the bank of that lake, and discharges in a small stream that runs under the Erie Canal. The banks of these lakes are formed of sulphate of lime. There are deep fissures and chasms around the border of the "upper lake," and also deep sinks in which large trees are swallowed up. Such is the condition of some of the districts that border Lake Ontario, and therefore belong to the history of the lake, as connected with its mysterious changes of surface.

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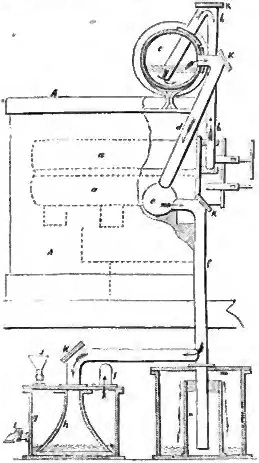
On the Manufacture of Gas from Wood or Turf.

Communicated to the London Mechanics' Magazine by Mr. John Ayliffe, Jr., of Moscow.

The annexed figure is a side view of a retort-bed for three retorts, with its appurtenances, for making illuminating gas from wood or turf, which I consider to be worthy of notice, as it may be of great service in countries where wood or turf is cheap, and lime and coals difficult to be got. It has the great advantage, moreover, of not requiring purification. According to many experiments which I have made in Moscow, I find that the gas from wood is a great deal cheaper than that from coals; that it is not so injurious to health; that the retorts may be worked much longer; and that six times the quantity of gas can be made in the same time, with the same number of retorts.



The following is the explanation of the figure:

A A is a retort-bed, with three retorts, *a*, *a*, *a*, into which the wood is placed to be carbonized. *b* is the ascending and dip-pipe, by which the gas is conveyed into the hydraulic main, *c*. *d* is a pipe through which the gas is made to pass into the ball, *e*, which is fixed in the bed, and heated to a dark-red heat. The gas passes from this ball into the naphtha cistern, *g*, in the basement of the works, through the pipe, *f*, which conveys the liquid passing over with the gas into the cup, *n*. The cup, *n*, stands in the box, *m*, which acts as collecting box for all refuse. *h* is an inverted bell in the cistern, *g*, intended to spread the gas, so that it may be well washed with the naphtha, or with coal-tar and 6 per centum of turpentine. *l* is a cock, to try the height of the naphtha in the cistern, *g*, and *j* is a funnel by which the naphtha enters that vessel. I is the outlet-pipe, which conveys the gas to the condensers, where it may be stored for use without requiring purification.

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Further observations on Major Barnard's "Theoretical Investigation of the Caloric Engine."

To the Editor of Appleton's Mechanics' Magazine.

SIR—I have read Major Barnard's last communication on the subject of the caloric engine with much surprise. Statements relating to demonstrable facts emanating from so respectable a source, ought to be reliable—yet it will be seen that Major Barnard rests his entire argument on erroneous assumption and mistakes. Unable to change the result of my computations by any other process than by *assuming* a *lower* temperature than that *on which they were based*, he selects just such a degree as will bear him out in his argument, viz. 440°. This, he asserts, is the maximum that can be carried or has been carried. On this important point, which forms the groundwork of all his calculations, I plainly tell Major Barnard that he has misstated fact; for, during the entire series of experiments with the double 72-inch cylinder caloric engine, 1851 and 1852, his imaginary maximum was exceeded by more than 100°. Frequently, as Messrs. Pike have good reason to know, the boiling temperature of mercury was exceeded, and, in consequence, the thermometers were broken repeatedly. Now, these thermometers were suspended in the centre of the opening between the regenerator and heater, which measures 8 by 18 inches. Less of speculation, and more of actual practical knowledge, would have saved the Major from committing so gross an error, and imparting so much erroneous information. I shall omit any further discussion of the fancied maximum of 440°, suggesting merely, that cast-iron is subjected to a much higher temperature in various practical operations. The boilers for melting lead, for instance, are subjected to a temperature ranging between 600° and 700°, and last for years. As to the heaters of the before-named 72-inch cylinder caloric engine, Major Barnard is hereby formally invited to inspect the same at Messrs. Hogg & Delamater's works in this city. Those interested in the matter have examined these heaters very carefully without detecting the slightest imperfection; in fact, the iron appears in all respects as when the casting left the foundry. I can state, in candor, that if I were asked to give good reasons why these heaters should *not* last during five years' constant use, I would be quite unable so to do. As to the fact of the temperature to which these heaters were subjected having ranged between 500° and 600° during the prolonged trials, 1851 and 1852, certificates will be produced, should ever the question assume such a character as to call for it.

Reflecting, practical men, and engineers of experience express surprise at the tone of Major Barnard's last communication in relation to the caloric engine, as it is evident to them that he brings no other knowledge to bear on the subject than a general acquaintance with the laws of dynamics, and the knowledge derived from conflicting tables showing the rate of expansion by heat, of the truth of which he knows nothing *practically*. Major Barnard's entire criticism would lead to the inference that nothing is accurately known, and that even the thermometer had never been applied to the caloric engine—what grounds there are for these suppositions will appear in proper season. Before entering further on the subject, let me say one word in relation to Major Barnard's mode of proving his position. The attentive reader cannot fail to observe that the matter is treated very clumsily, and that the entire question admits of easy demonstration—just such a "meagre" demonstration as I presented in my last communication—without resorting to a process which is not comprehended by those who are most anxious to be instructed—a process frequently adopted to exhibit learning, and well calculated to throw dust in the eyes of the majority of readers. Gentlemen not long from college, a learned professor also from the north of Europe, have lately instructed me on the theory of my engine in mathematical language most learned. The readers of the Mechanics' Magazine have for some time been threatened by the former, and to save them from the threatened infliction, I made an allusion to smatterers in my last communication, which probably will effect the desired end. That allusion, it is proper to observe, was *not* intended as applied. I will now proceed. The history of invention records many amusing instances of condemnatory opinions having been given against new inventions by those who knew less than the inventor; but an instance of greater discrepancy of information than the present can probably not be found. Major Barnard will admit that he knows nothing of the caloric engine, excepting what he infers from the general laws of compression and dilatation, Poisson's investigations, Regnault's tables, &c., whilst the writer has built more than twenty caloric engines, possessing the experience gained in compressing and heating upwards of ten thousand tons of atmospheric air—having all the while (Major Barnard's supposition notwithstanding) made very free use of the thermometer, and having devised and applied various instruments for measuring the temperature where thermometers could not be applied; in fine, acquired knowledge, based on experiments of a greater magnitude than that of all other experimentalists put together, ten times told. Major B. will say, *publish* the results of these experiments. Practical men, those who expend their means with a view of ultimate profit, can give very good reasons why every thing should not be at once published relating to a patented invention. There are at present a host of imitators who understand the matter perfectly, and whose acts furnish excellent reasons for not giving publicity to every fact relating to the matter. This argument Major Barnard will probably not admit, since he can find no formula or equation for testing it. I will communicate enough, however, to prove that his opinion of the caloric engine is worthless, and that his wholesale denunciation of the contents of my former communication is mere braggart assertion. I will not waste space by discussing the propriety of adopting Regnault's tables in preference to those of Dalton, Gay Lussac, Le Roy, and others, neither being correct in practice. I will simply remind Major Barnard that the minute quantities of air which these philosophers experimented on had been previously subjected to a delicate process of freeing it from moisture, &c., whilst the air on which I have been experimenting has been such as the surrounding atmosphere furnishes under the vicissitudes of temperature and moisture; nor have I experimented on infinitesimal quantities confined in little glass vessels surrounded by non-conductors. It is the result of compressing many hundred tons of air during each trial, in cylinders freely exposed to radiation, with thermometers placed at various points in receivers and passages, on which my experience is founded, and on which my calculations are based. A tyro in experimental philosophy would scarcely think of making a direct application of tables of rate of expansion to the caloric engine, even were they quite reliable, without ascertaining the effect of, and making allowance for the effect of radiation, &c. Major Barnard, however, insists on a direct application, and without leaving his desk he settles the whole question. In relation to my statement defining the heat acquired by compression, he assures the readers of the Mechanics' Magazine that "this assumption of 60° increased temperature is not established by either argument or experimental facts, and it is not in conformity with the laws of developed heat established by others." In reply I tell him that the result of actual trial of many weeks' duration with supply cylinders of 58 inches diameter *has* established a mean increase of temperature developed by compression, ranging somewhat above 60°, as stated in my former communication—varying slightly, according to the state of the atmosphere, radiation of the supply cylinders, modified by currents in the engine-room, speed of engine, and other minor causes.

With the foregoing preliminary remarks the subject might be readily disposed of, but for the complex and entangled character of Major Barnard's "Investigation." I will endeavor, however, to arrange his argument under distinct propositions, and, if possible, render the points intelligible on which he has raised an issue, viz.:

1st. *Increase of volume by the development of heat in the supply cylinders.* Major Barnard, instead of admitting that in his original calculations he had committed the error of not estimating this increase of the volume furnished by the supply cylinders, nor the consequent increase of mean resistance against the supply cylinders, now charges me with the monstrous fallacy of viewing that increase of volume as *power*. Can he point out any where in my estimate that the said increase has been treated as power? In order to show the magnitude of the oversight in question, I stated the additional supply of air furnished to the receivers at 173·3 cubic feet per stroke, and the force thereby exerted on the working pistons to be 299·462 lbs. per stroke of the 4 cylinders; but mark, I did not forget to estimate the corresponding resistance against the supply pistons. My former statement, then, that the development of heat by compression causes an increase of volume furnished to the receivers of ¼th, I now reassert, and also that the mean resistance against the supply pistons, under 12 pounds + pressure, will be 9·33 pounds per square inch. I must here observe that all my calculations are based on 480°, and not 491°, required to double the pressure, my long experience having verified the former as nearest correct. Again, let me be understood to treat of common atmospheric air in its ordinary hygrometrical state; also, that on practical considerations, I consider it absurd to embarrass the question by taking into account the varying densities and capacities for heat which attend the continual changes of atmospheric temperature.

2d. *Fall of temperature by expansion in the working cylinders, and assumed incapacity of the heaters to restore the temperature.*—Major Barnard says, in regard to the capability of the heaters to keep up the temperature, after the closing of the cut-off valve: "Now *I* object most strenuously to the application of the law of Mariotte in this case; and I will show that the accession of temperature from the heaters demanded to maintain that law, is entirely beyond the power of the heaters to supply;" and he then goes on to prove, by Poisson's formula, that the fall of temperature of the air under the working piston, by expansion, will be 121°, and adds, "it is utterly impossible that it should receive a tenth part of this required accession in the required time." On the strength of this assumed great diminution of temperature and inefficiency of the heaters, he proves that at the termination of the stroke, there is no force under the working piston—see his diagram. *I* will prove presently, in its appropriate place, the impossibility of the supposed fall of 121° of temperature. I will first test the question by practical evidence. It is unfortunate for Major Barnard that his assertions and representations are met at every step by opposing *facts*, and that the elaborate demonstration proving the working piston to exert no power at the end of the stroke is completely refuted by experience.

In order to ascertain, during the recent trials of the caloric ship, the resistance opposed to the working pistons in the down stroke, delicate mercurial gauges were applied to small apertures on the top side of the pistons. The test being completed, the action of the gauges was reversed by means of a stop-cock; a pressure was thereby exhibited quite unlooked for, as the heaters were not tight. With a working pressure not quite 8 lbs. to the square inch, a column of mercury 3 inches high was overbalanced—the mercury blowing out with great violence just as the piston was within one half inch of the full up-stroke, showing an active internal pressure approaching, if not quite, ·2 lbs.; the cut-off being set at ¾, the law of Mariotte demands a pressure of 4 : 3 :: 23 : 17·25—15 = 2·25 lbs.; thus an incontrovertible evidence is furnished, that the heaters had full power to restore the heat lost by expansion. The result of other experiments present yet stronger evidence in the matter. A caloric-engine, at the works of Messrs. Hogg & Delamater, of 30 inch working cylinder, divested of the regenerator, has made 60 strokes per minute by the mere action of the heater. Engineers of great intelligence have witnessed these experiments. The working and supply cylinders being as 3 to 2, and the cut-off set at ¾, Major Barnard with his ready figures can easily calculate that a temperature of some 300° must be imparted by the heater in this case, in less than ⅙ a second. Seeing thus that an accession of 300° takes place in so short a space of time, what value can be attached to Major Barnard's calculations and his positive assertion, that "one-tenth of 120° could not be acquired in 2 seconds." I forbear making any comment on this utter want of needful information, though I cannot refrain from suggesting, that heavy responsibility is inseparable from a course calculated to retard the progress of an important enterprise, when the reasoning on which its condemnation is principally founded rests on such erroneous premises. If Major Barnard will pay a visit to Messrs. Hogg & Delamater's works, every opportunity will be cheerfully afforded him of examining several small caloric engines in operation. He will find these engines capable of making 180 turns a minute, and learn practically that in ⅙ of a second the air under the working piston acquires 300° of temperature. He may decide for himself by what means that temperature is acquired. The air in its course to the working cylinder passes through the regenerator at the rate of 40 feet per second. The regenerator being only 2¾ inches, or 0·23 foot in thickness, it will be found that each particle of air occupies only $\frac{1}{174}$ of a second in passing through the instrument. Now, whether Major Barnard decides that the 300° are acquired in the $\frac{1}{174}$ of a second passing the wires, or in the ⅙ of a second exposed to the action of the heater, or whether he makes up his mind that both are contributing to produce the amazing result, he cannot fail to learn practically that heat is not so sluggish as he has supposed. Perhaps, also, he may discover that there is such a thing as *radiation* to assist his "*convection*" in transmitting the caloric, and preventing the asserted diminution of 121° under the working piston of the caloric-engine.

[To be continued.]

Pisciculture, or the Repeopling of Streams with Fish.

Among the valuable contributions to practical science communicated by M. Jerome Nickles, of Paris, to a late number of Silliman's Journal of Science and Art, few will be read with greater interest than the following on the artificial rearing of fish, an experiment which has been in practical operation for a sufficient time to prove its complete practicability.

M. Nickles gives to M. Rémy, the modest fisherman of the Vosges, the credit of establishing the "manufacture of fish" in France, a branch of industry which will, doubtless, be extended to every country where inundations, and other accidents, the introduction of dams, and the increase of navigation, particularly steam navigation, may threaten the destruction of the most valuable varieties.

A paper by M. Haxo, secretary to the Société d'Emulation des Vosges, gives the history of this important invention, and reviews the means employed by Rémy for populating with trout the streams of his neighborhood. This fisherman observed the time when the female deposited its eggs; he remarked that the male then comes and spreads over it the fecundating liquid; and, as our observer could but imperfectly protect these eggs from the various chances of destruction, he learned how to imitate nature, by promoting the parturition of the female, and then that of the male, and placing the eggs in the conditions most favorable for their development; he had thus the happiness of seeing the breeding of a certain number of trout, and noticed their preserving under the venter a part of their eggs, and living during some time at the expense of the rest.

But this was not all: it was necessary to provide for the ulterior preservation of the young animal by a practicable process. The obscure fisherman, who hardly knew how to read, did not yield before this difficulty: he set at work observing again; he placed some frogs in the basin containing the young trout, judging with reason that the spawn of these batrachians would be a resource for the spawn of the trout; he gave them also bits of veal as they grew larger. But, as these aliments, though successful, would be too expensive, Rémy, not knowing of the existence of the sciences of botany and chemistry, contrived a process based on one of the great laws of nature. He planted some herbivorous fishes in the water which contained the carnivorous trouts, and from this moment he had no more trouble with the raising of his "élèves." In the course of six years, with very limited means, Rémy, who was in the interval associated with Géhin, had bred several millions of salmon and trout. After he had been for six years thus preparing the living food for his fishes, M. Haxo made known his results to the Academy of Sciences, and the government ordered a full investigation into Rémy's process. Pisciculture was established in the basins of the canal of the Rhone, on the Rhine at Luningue, in the department of the Upper Rhine, not under the direction of Rémy or of Géhin, but of M. Coste, who had succeeded in appropriating to his own profit the labors of the modest fisherman. A spirited dispute ensued, which continues still, and has engaged several independent pens, as MM. Haxo, Victor Meunier, the journal "La Presse," the Abbé Moigno, &c., who defended the rights of the oppressed against the despoiler. Justice will be done; Rémy will receive a pension as a national recompense.

I pass in silence the reclamations of priority, and the attacks of all kinds which have accompanied the success of Rémy. My last communication on hot-air engines has shown how such facts are rapidly produced whenever there is success.

The following is briefly the method employed in this new branch of industry. Through M. Millet, inspector of forests, the processes are become so simple that they can be executed by the most inexperienced hands. The administration of the waters and forests is now organizing a regular service for effecting a repeopling of the waters of navigable streams. The apparatus of M. Millet is placed in the hands of the fish-keepers, and the living alimentary material will be manufactured, so to speak, at all points. The details which follow are taken from a work yet unpublished on Millet's process, which I have seen in the course of its preparation.

Two boxes of lead, 1 meter long and 1 to 2 decimeters broad, and 5 to 6 centimeters deep, are disposed in steps in the fireplace of his apartments. Some frames or sieves of hair, flags or metallic network, &c., contain the eggs. According to the species, these eggs are immersed to a depth of one or several centimeters. These frames may be withdrawn or replaced at will by means of tringles, which support them by pressing against the side of the box. A reservoir of water, furnished with charcoal and gravel, is near by, and turns into the box, drop by drop, filtered water, furnishing about 2 or 3 litres of water per hour. The water is thus always in motion, and it is only necessary to fill the reservoir each morning to keep the apparatus in action without supervision.

The total expense of the establishment is but 6 francs. With 35 litres of water for six weeks, M. Millet has bred about 25,000 trout or salmon, and he expects to breed some millions of different species in the course of the year.

In order to obtain the eggs from the female, M. Millet employs nearly the process used by Rémy and Gehin. He makes the eggs to pass out only as they are mature, leaving an interval of two days between each operation, this consisting in passing the finger lightly over the surface of the abdomen of the female. Another process consists in inclosing the female in a cage with a double bottom, formed of bars rather far apart; the females drop their eggs by organic contraction, and aid themselves in it by rubbing against the bars. The eggs fall upon the frame. The males are then introduced, and often they fecundate the eggs at once, being incited to it by the presence of the female and the odor of the eggs; but if not so, it is provoked by slight friction, as in the ejection of the eggs from the female.

Another result of interest is that M. Millet has caused trout and like species which live in running streams to breed in standing waters, by causing some aquatic plants to grow in the water.—The species which I have seen employed was the *Lemna minor*, (duck weed).

This experiment calls to mind the "organic equilibrium" of Mr. Warrington. It is known that this chemist has for several years kept in a glass vase full of water, a small aquatic menagerie, consisting of a *Valisneria spiralis*, several fish (species of Gasterosteus), and some aquatic univalves, without injuring the purity of the water. It is seen that the carbonic acid and azotized products given out by the animals are absorbed by the plant, which converts at the same time the carbonic acid into oxygen. The debris of the plant serves as nutriment to the snails, whose eggs, in their turn, feed the fish.

The process of M. Millet has been put in practice in several places near Paris, and repeopling the rivers has been already begun. Contrary to the prescription of Rémy and Géhin, who nourished the young for some time on the spawn of frogs and coagulated blood, after the pouch under the venter had disappeared, M. Millet commences the distribution of them whenever this period has arrived. The future will show whether the method just mentioned is wise, or whether it will not be necessary to return to the process of Rémy, which consists in "sowing" herbivorous fishes in the streams populated by the trouts. M. Millet is still engaged in his labors, and we shall endeavor to keep our readers acquainted with the progress of this new branch of industry.

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Newton's Gold Washer.

This late English invention relates to a mode of subjecting pulverized ores to the combined action of water and quicksilver, for the purpose of amalgamating the metallic particles thereof with the quicksilver, and of driving off the earthy and other refuse matters.

Fig. 1.

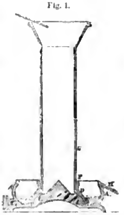

Fig. 2.

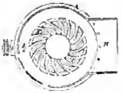

Fig. 1 is a vertical section of the apparatus employed by the inventor for the purpose; and fig. 2 is a plan view, with the vertical water and feed-pipe and conical cap removed. A, is a circular vessel for containing mercury, and provided with a rising conical bottom. On the surface of this conical bottom numerous curved grooves C, C, are formed, through which the water and pulverized ore are passed into the quicksilver. These grooves are covered with a hollow cap D, screwed firmly down through its flange E, and having a hole F, in its top, to receive the feed-pipe G, which fits in tightly, and is high enough to contain a column of water sufficient to force its way, with the pulverized ore, through the said grooves and the quicksilver in the vessel A, and pass off through the discharge-spout H. The mercury vessel is provided with an outlet I, for discharging the amalgam as often as may be necessary.

The operation of the apparatus is as follows:—The pulverized ore is placed on a sieve at the top of the feed-pipe G, and a constant stream of water is applied thereto; whereby the fine gold or other metallic matter is washed through the meshes of the sieve, and down the pipe into the diffusing grooves C, C; the pipe being meanwhile filled to a height sufficient to countervail the resistance of the heavy body of quicksilver, and force the metallic matter through the grooves at the bottom of the vessel A, into the mass of quicksilver. By this means the metallic particles become thoroughly mixed with the quicksilver, and the water and other light matter, rising up to the edge of the mercury vessel, pass off through the discharge-spout H; while the gold or other metal is taken up by, and amalgamated with, the quicksilver. This amalgam is drawn off as often as it may be necessary, by removing the plug from the outlet-pipe I; and a fresh supply of mercury is then placed in the vessel A, ready for the next operation.

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Samuelson's Patent Digging Machine.

It is well known that the produce of land cultivated by market gardeners and by cottagers far exceeds that obtained from the same area by the farmer. That excess is obtained chiefly at the expense of increased labor in deep tillage, irrigating, singling, and cleansing. It is only of late that a serious effort has been to assimilate our practice as farmers to that of the gardener. In the growth of root crops the water-drill is but just beginning to perform that in the field, the omission of which in the garden would be considered as the height of neglect. In growing corn, we still adhere to the extravagant practice of thick sowing, whether broad-cast or by the drill; though we may see in the laborer's allotments how much superior, both in the straw and in the ear, is the crop which he has "dibbled" with one-third the quantity of seed. The value of horse-hoeing is doubted by many who would not allow a weed to remain in their gardens; and we still endeavor to make up by wagon-loads of manure and by tons of guano for imperfect tillage and want of drainage, which permit their most valuable constituents to be washed off the surface into the ditches and streams; whereas by converting our fields by deep tillage into one vast filtering bed for their retention, we should not only avoid this waste, but avail ourselves to the utmost of the valuable dressings that descend with the rains of heaven, the ammonia contained in which, according to our chemists, represents an annual value of quite twenty shillings per acre, estimated at the price of guano.

It is to the element of cultivation, namely, the effective pulverization of the soil and preparation of the seed-bed, that Mr. Samuelson, the well-known agricultural engineer of Banbury, has contributed the invention of his digging machine, which has been for some time past at work in that neighborhood. It consists essentially of several series of slender steel prongs, so shaped in curve and section as to penetrate the soil easily by the mere weight of the framing which contains them; each series resembling the spokes of a wheel without the tyre, and all the wheels being caused to revolve by the draught of the horses, whilst embedded in the earth up to what may be called their naves. The spokes or prongs bring up the soil, and allow it to fall backward, thoroughly pulverized and mixed, in a form not unlike the backwater from a paddle-wheel. In the upper portion of their revolution they pass between a corresponding number of strong iron bars, which scrape away any earth or weeds adhering to them. Although, like all other tillage implements, it works best in dry weather, the digger was used with advantage during the early spring, when it was hardly possible to plough at all; it also clears itself well of any stones which it may pick out of the ground.

From the description which we have given, it will appear that it is, in fact, a trenching implement, propelled by horses—loosening, and partially bringing the subsoil to the surface, and thoroughly reducing the whole, like the fork; and not merely cleaving off a slice, and reversing it like the plough; but as it only requires four or five horses to work it when set to dig ten inches deep by three feet in width, being equal to four acres dug in a working day of seven hours, in soils where it is rare to see less than three horses ploughing only one-fourth of that breadth to a depth of barely six inches, it is obvious that, apart from the superiority of the result, there is positive economy in the power applied. Circular motion, which generally accompanies the application of steam power, will, we trust, in this instance, as in that of the horse-power threshing machine, prove to be only its precursor; meanwhile, it is perhaps quite as well, with reference to the speedy and general adoption of this new cultivating machine, that its introduction is not dependent, in the first instance, upon that of the steam engine.

In conclusion, we must not omit to notice the application of the "Digger" to works of road formation and excavating generally. It moves as much surface soil in a day as would require forty to sixty men with the spade.—*Canadian Journal.*

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Proceedings of the London Institution of Civil Engineers.

From Newton's Repertory of Arts.

The paper read May 3d, 1853, was "*A Description of the Chesil Bank (Portland)*, by Mr. J. Coode, M. Inst. C. E.

The author, in his position of resident engineer of the "Portland Breakwater Works," now in course of execution under Mr. J. M. Rendel, President Inst. C. E., had for a long time directed his attention to the extraordinary accumulation of shingle, called the Chesil Bank,—one of the most remarkable features of the southeast coast of England.

It consisted of a vast mound of shingle, in the form of a narrow isthmus, lying upon the western sea-board of Dorsetshire, between Abbotsbury and Portland; its length was 10½ miles in a southeast direction, and its breadth at the base or level of low water at ordinary spring tides was 170 yards, near Abbotsbury, and 200 yards at Portland. Along a portion of its course, south of Wyke, the bank acted as a natural breakwater to the anchorage of "Portland Roads," affording shelter from the westerly and southwest gales. The height increased from the northwest, but the inclination of the crest was not uniform throughout; the rise between Abbotsbury and Wyke being at the rate of 1 in 8450, whilst that between Wyke and Portland was 1 in 880.

In a transverse direction one general slope appeared to exist, from the summit down to a depth of 3½ to 4½ fathoms below low water; the rate of inclination varying from 1 in 5½ to 1 in 7. In the next depth of 2 fathoms, the slope was 1 in 8 to 1 in 11;—outside this the slope was about 1 in 30 to a depth varying from 6 to 8 fathoms, at which point the shingle ceased entirely, and was succeeded by fine sand.

It had been generally supposed that the nucleus of the bank was formed of a mound of clay; repeated trials by boring had, however, shown that the bed on which the shingle rested, on the east, was the edge of the Kimmeridge clay of the east bay; and it was only that side that it could be reached by boring tools. The bank consisted in reality of shingle, mixed in places with sand, and so compact as to prevent the percolation of water, except during heavy gales from the southwest; notwithstanding that at certain times the tide rose nearly 3 feet higher on the west than on the east side of the bank, and in heavy gales the waves ran up the slope as much as 10 feet vertically.

The largest shingle was generally found "to leeward," or farthest from the point whence the heaviest seas proceeded; and so clearly was this defined, that a Portland fisherman was popularly said to be able to distinguish, in the darkest night, any precise spot of the beach "by the size of the pebbles."

The shingle composing the bank consisted chiefly of chalk flints, with a small admixture of pebbles from other formations, and in an interesting geological examination of the coast, the author traced the principal supply of shingle to have been derived from the chalk cliffs to the westward, between Lyme and Sidmouth, and from the vicinity of Beer Head. Other shingle, of distinct character, proceeded from Budleigh Salterton; and other pebbles from Aylesbere Hill, inland, being brought down to the coast by the river Otter.

The question was next discussed as to the power by which shingle was conveyed from a distance of between 40 and 50 miles, and deposited in the form of a high mound. The action of tidal currents was carefully examined, and after admitting that they did sometimes modify the extent and form of accumulations of shingle, and referring to the late Mr. H. R. Palmer's paper "On the Motion of Shingle Beaches," additional reasons were given against the sufficiency of this tidal action to produce such results. Instances were then cited of shingle travelling in opposition to the prevailing current of tide; and having shown that the progress of the shingle could not be attributed to the action of the tidal currents, the effect of the wind waves was attentively considered. The prevalence of west and southwest winds on the coast was demonstrated, from the observations made at Plymouth with Whewell and Osler's anemometers, by Sir W. Snow Harris, for the British Association, and it was shown, that lines drawn across the bay, in the direction of the heaviest and prevailing winds, would intersect the points whence the shingle had evidently been derived; it was shown also, that the seas driving along the west side of Portland sufficed to arrest the progress of the shingle; and the evidence adduced led irresistibly to the conclusion, that the ultimate movement of shingle was always found to be in the direction of, and never against, the drift of the heaviest seas, but frequently in opposition to the prevailing tidal current.

It appeared evident that neither the action of the stream at Abbotsbury nor the flow of the tide in the fleet could have moved the mass, or piled up the mound of shingle composing the bank. The sudden depth of 8 fathoms of water at a cable's length from the shore was a peculiar feature, and permitted the heaviest seas to fall with great violence, and without the retardation and loss of force usually experienced on long shelving beaches.

Evidence was then adduced that shingle was moved at a much greater depth than was usually supposed: the author, in his researches, found that at one time the pebbles down to the edge of the sand were incrusted with barnacles, "balanus balanoides," and subsequently, after a continuance of heavy gales from the southwest, the shingle down to the lowest point was found to be completely freed from incrustation; demonstrating that there had been considerable motion of the pebbles at a depth of 8 fathoms below low water of spring tides.

The formation of the gullies or "cans," in the face of the bank, caused by the partial percolation, was then noticed, as tending in some degree to produce the flat slope on the east side.

The author considered the cause of the largest shingle being found to "leeward" was, that large pebbles were more easily moved than those of small size, inasmuch as the former were generally of exceptionable dimensions, were usually found on the surface, and offered nearly the whole of their surface to the action of the waves; whereas the latter, forming the bulk of the mass, were more uniform in size, were closely embedded together, and exposed little more than their upper surfaces, over which the waves had a tendency to travel, rather than to lift them from their bed. Thus the larger stones were rolled about by every wave, whilst the small pebbles were only moved in a mass, and received their abrasion whilst settling down again to form the even uniform surface of the beach.

After a heavy gale and a ground swell, the large shingle was entirely scoured away. The small shingle was thrown up to the crest or top of the bank, during the height of heavy gales, out of the reach of ordinary waves, or the clawing action of receding water.

By sections of the profile of the bank, taken after a heavy gale from the southwest, at right angles to the direction of the bank, the general form was shown to be nearly that of a true parabola, with the axis inclined to a level line to the extent of 1 foot in 90 feet.

Mr. Palmer's views as to the "accumulative" and the "destructive" action of waves were then examined,—the author's observations inducing him to fix other limits: the rule, so far as one could be formed, being in his opinion, that seven, or any less number of waves per minute, induced the "destructive" action: and nine, or any greater number, in the same time, the "accumulative" action: it being admitted that shingle always accumulated with off-shore winds, and was scoured off during on-shore winds, and especially by the subsequent ground swell; bearing in mind, however, in watching the course of the crest of the wave, after breaking, that if it fell upon the water of the preceding wave, then returning down the slope of the beach (as was the case when waves followed in quick succession), the "accumulative" action was going on; but if the water descended directly on the pebbles (as when the waves broke at longer intervals), the "destructive" action was progressing.

The rapidity with which the water ran off or was absorbed would influence the result, and that was to some extent contingent on the slope of the beach, and also on the nature and degree of compactness of the material of which it was composed.

The paper concluded with some instances of the effects produced on the Chesil Bank by heavy gales from the southwest, and it was stated that on such occasions it was not an uncommon occurrence (when the advancing wave met the receding water of the wave immediately preceding it) to see an enormous mass of broken water and spray rise vertically to the height of 60 or 70 feet. This force had on several occasions crushed inwards the decks of vessels stranded on the beach.

During the gale of the 27th December, 1852, the quantity of shingle scoured away between Abbotsbury and Portland was 3,763,800 tons; and the quantity thrown in within the next eighteen days was 2,671,500 tons.

On the 23d November, 1852, a heavy ground swell, consequent on half a gale of only four hours' duration from the southwest, scoured away within eighteen hours 4,553,000 tons; and in five days afterwards, 3,554,200 tons of shingle were found to have been thrown in again. These quantities were derived from careful admeasurement of the profile of the bank.

The paper was illustrated by a large series of diagrams, of the sectional profiles of the bank, and the outlines of the shores, exhibiting the geological features of the coast, with the bearings of the prevalent winds, &c., together with a collection of specimens of the shingle, taken at four different points along the bank, and at various levels, from the top down to a depth of 8 fathoms below low water of spring tides.

The evening of May 10th was devoted to the discussion of the above paper.

After passing deservedly high encomiums upon the paper, it was remarked, that however acute and scientific the observations might be on this particular locality, it would not be prudent to receive the conclusions as applicable to beaches in general, under all circumstances,—in fact it would be safer not to generalize upon this or any other isolated case.

As to the position of the large shingle:—on any shelving shores, where the waves could only act upon the beach at or about the time of high water, the larger pebbles were found near the top, after the occurrence of storms; because, under such circumstances only, did the waves exert sufficient power to break heavily upon the beach; under light winds the force of the waves was expended in the shoal water before reaching the beach.

Instances were given of the motion of shingle as affecting the entrances of harbors, which was the main practical point to be considered by civil engineers. At Lowestoft, just as much sand was washed up as supplied that which was required for ballasting the vessels frequenting the port. At Sunderland, the cross action of the waves, influenced by the ledge of rocks outside the new harbor, caused a deposit of shingle on the opposite sides of the groins.

The work of Lamblardie on the motion of shingle (Mémoire sur les Côtes de la Haute Normandie) was referred to as corroborating the views of the author of the paper on the motion of "beach" by the wind-waves, and giving valuable facts, bearing on the subject.

Viewing the relative position of the geological strata of the coast to the westward of Portland, it was considered probable that the extent of chalk exposed to the action of the waves had, at a former period, been much greater than at present; that the disintegration of the underlying green sand had expedited the fall of the chalk and flints, and thus supplied the material for forming the bank.

The travel of pebbles was gradual, and distinctly up and down the beach, having an onward tendency in the upward motion, and yielding to the force of the then existing wind-wave. At an angle of about 45°, the greatest amount of travel or onward movement was observed; but the size of the shingle, more especially, was determined by the amount of undulation.

So much interest had been excited by this paper and by the valuable facts laid before the meeting (and it was evidently within the power of so many engineers to transmit the results of their observations on the shores adjoining the works under their charge) that an appeal was made from the chair for their attention to so evident a mode of benefiting the institution, whilst the best interests of science would be advanced.

On May 17th the first paper read was "*On the caloric engine*," by Mr. C. Manby, M. Inst. C. E. (Secretary.)

At meetings of the "Société d'Encouragement pour l'Industrie Nationale," on the 26th January, 1852, and of the "Académie des Sciences," on the 2d February of the same year, Mons. Galy-Cazalat entered upon an examination of the principles of Ericsson's caloric engine, assuming it to be composed of parts analogous to a non-condensing steam-engine.

After describing these component parts, and their several uses and relative bearings, he gave the following quotation from Ericsson's English Patent of December 26th, 1850: "The invention consists in producing motive power by the application of caloric to atmospheric air, or other permanent gases or fluids, susceptible of considerable expansion, by the increase of temperature,—the mode of applying the caloric being such, that after having caused the expansion, or dilatation which produces the motive power, the caloric is transferred to certain metallic substances, and again retransferred from these substances to the acting medium at certain intervals, or at each successive stroke of the motive engine; the principal supply of caloric being thereby rendered independent of combustion, or consumption of fuel accordingly, whilst in the steam-engine the caloric is constantly wasted by being passed into the condenser, or by being carried off into the atmosphere.

"In the improved engine, the caloric is employed over and over again; enabling me to dispense with the employment of combustibles, excepting for the purpose of restoring the heat lost by the expansion of the acting medium, and that lost by radiation also, for the purpose of making good the small deficiency unavoidable in the transfer of the caloric."

These passages would have led to the idea of a perpetual motion, but that the well-known law governing the elastic force of gases at various temperatures demonstrated the erroneous principle on which the presumed economy of the caloric engine was based. It was contended, that if the degree of elastic force of a gas was directly proportioned to the amount of caloric combined with it, a certain mechanical power must be exerted to abstract that caloric from the gas, and no filter could retain any portion without opposing such a degree of resistance as would destroy the economy.

Arguing upon the generally-received dimensions of Ericsson's engine, it was demonstrated, that in order to arrive even at a less amount of economy of fuel than had been claimed for the machine, it was requisite that the air leaving the cylinder should traverse the meshes of the metallic web in the "regenerator," without cooling by expansion; or in other words, preserving the elastic force of two atmospheres, primarily possessed by it, in the working cylinder. But this force, being reduced to the sum of the resistances of the atmosphere and of the "regenerator," the sensible heat was reduced by the amount employed in expanding the air, without being usefully transmitted to the metallic web. The result was, that the escaping air carried off almost all its latent heat, expanded into nearly twice its previous volume; the insignificant portion of sensible heat imparted to the metallic web being proportioned to the weight and bulk of the metal, and corresponding with the diminution of the volume of air.

It was argued also, that in practice the caloric engine would be more simple and economical if the "regenerator" were suppressed, and a greater extent of heating surface were given to the air vessels; as the surface was now so small that two-thirds of the fuel were uselessly consumed; and therefore that any present apparent economy could only be made on one-third of the fuel effectively employed.

In calculating the economy of fuel by the use of the "regenerator," the following formulæ were employed.

To find the mean temperature of the "regenerator," before and after the passage of the air:—

$$t'' = \frac{tP + T(C + P)}{C + 2P}$$

$$t' = \frac{TP + t(C + P)}{C + 2P}$$

In which

P, represents the ratio of the weight of the copper to that of the air;
C, the ratio of the specific heat of air to that of copper;
T, temperature of hot air;
t, " cold air;
t'', the mean temperature of the "regenerator" after the passage of the hot air;
t', the mean temperature of the "regenerator" after the passage of the cold air.

The result was, that 285° Fahr. of heat were carried by the air at each stroke into the atmosphere.

Quotations were given from a letter addressed by M. Regnault to Colonel Sabine, Treas. Royal Society (dated April 1853), in which he stated, that he was about to publish, immediately, a series of elaborate experimental researches on various subjects connected with the effects of heat on elastic fluids, the results of which would solve many questions long in dispute, and by means of which engineers might accurately calculate the effect of a given amount of fuel, in whatever way it was applied. M. Regnault communicated, in anticipation, that he had arrived at the number 0·237 for the specific heat of air at constant pressure, and at 0·475 for that of steam under atmospheric elasticity,—the specific heat of water being taken in each case as unity.

"*The principle of the caloric or hot air engine*," by Mr. J. Leslie, M. Inst. C. E., was the next paper read.

The main objects of the author being to show that the "regenerator," or as he contended it should be called, the "economizer," was based on the correct principle of the rapid equalization of temperature of two bodies of unequal temperatures when brought into contact, and that it was practicably productive of economy of fuel; that the date of the production of Stirling's air engine was antecedent to that of Ericsson; and that the former was decidedly superior to the latter in the general arrangement, in the details of construction, and in general efficiency.

If it was admitted that the wire-gauze or thin plates did absorb the heat in the passage of the air in one direction, and give it out again on its return—it was contended at some length that there must be economy of heat, unless the mechanical power required to drive the air through and between the metallic webs in the "regenerator" was greater than the advantage to be derived from the alternate heating and cooling. It was contended that the required force was, in reality, very insignificant,—that it did not increase in proportion as the density of the air was augmented, and that by the removal of the "regenerator" the air engine would lose its power and its economy. That Stirling's air engine, at Dundee, did act efficiently for some years, and was only at last abandoned from the difficulty of preventing the bottoms of the air vessels from being destroyed by the direct action of the fire.

The apparatus called "Jeffrey's respirator" was instanced as an analogous application of the alternate heating and cooling of air in its passage between the metallic surfaces.

It was contended that to Dr. Stirling was due the merit of the invention of the economizing process on which the air engine was based, whilst to his brother, Mr. James Stirling (M. Inst. C. E.), must be conceded the practical reduction of the bulk of the engine by using compressed air; the latter improvement having been patented in 1827, and with other ameliorations in 1840;—that Stirling's engine was more compact than Ericsson's, and occupied less space, owing to the use of air compressed to seven or ten atmospheres, which increased the power of the machine directly in the ratio of the density of the air; and that in Stirling's engine, the working cylinder being a separate apparatus, connected only with the cool end of the air vessels, it never became heated to such an extent as to occasion the difficulty of lubricating, which had proved so prejudicial in Ericsson's and other engines.

The last paper read was "*On the conversion of heat into mechanical effect*," by Mr. C. W. Siemens.

In the first section of the paper the abandonment of the prevailing theory, that heat was material (though imponderable), was insisted upon, and it was shown to be untenable by Sir Humphrey Davy's experiment of melting two pieces of ice, by friction, against each other; by the experiment of Dulong, proving that although heat was absorbed in the expansion of gases, the specific heat of the gas was not thereby increased; and by the experiment of Joule, of Manchester,—who produced heat in several ways by mechanical effort only.

The "dynamical theory" was supported by proofs derived from French, German, and English authors of the present day.

It was explained that, according to that theory, heat was vibratory motion of the material particles of either solid, liquid, or gaseous substances. In the gases this motion was so great, that it completely destroyed cohesion between the particles; on which account they were better adapted to the production of mechanical effects by heat than either liquids or solids.

The elastic pressure of a gas was explained to arise from the impact of the vibrating particles against the sides of the containing vessel.

If the side yielded to the pressure, as was the case with a working piston, then the rebound of the particles would be less than their impact, and their length of vibration would diminish in proportion to the onward motion, or the mechanical effect produced.

The length of the vibrations determined the temperature, and their frequency the specific heat of a body. The product of the two multiplied by the weight constituted the *vis viva*, or latent mechanical force, and might be numerically expressed, if the specific heat of the substance were accurately known.

It was argued, that the same heat must always yield, in its conversion, the same mechanical effect, no matter what the nature of the material employed might be. In illustration, a formula was given which expressed the H. P. of any steam or air engine by the temperature lost in the working cylinder, which formula was recommended for practical use, instead of the more complicated and uncertain method usually employed for ascertaining the force of expansive engines.

The total power to be derived from an expansive steam-engine was illustrated by a diagram, from which it appeared that the full theoretical equivalent for the heat employed might be obtained theoretically, though not practically, provided the steam was admitted into the cylinder at the pressure of about 18,000 lbs. per inch, or of equal density with the water producing it, and was allowed to expand to at least 18,000 times its original bulk below the working piston. Its temperature would, during this expansion, fall from 1200° to 100° Fahr., and it was shown that each degree yielded an equal share of power. The specific heat of steam was shown to be much greater than was generally supposed; and the supposition lately advanced by Rankine and Clausius, "that steam partially condensed in expanding," was held to be erroneous in consequence, and was certainly not corroborated by the form of actual indicator diagrams which were exhibited.

In the second part of the paper the practical and theoretical conditions of air-engines were examined, and were illustrated by diagrams.

The result arrived at in this examination—of the general case of an air-engine, consisting of an air-pump, a heated reservoir, and a working cylinder, into which the heated air was admitted for such a portion of the stroke as to obtain the maximum expansive action,—was, that "theoretically, it was not superior, and practically, it was much inferior, to an ordinary condensing steam-engine." There was, however, this important difference between the two classes of machines, that the unproductive portion of the heat required by the steam-engine was expended in the boiler, effecting increase of bulk without displacement of piston, whilst in the air-engine, it presented itself at the exhausted port in its free (sensible) state, and might be usefully employed in partially heating the fresh supply of compressed air to the cylinder.

The air-engine by Stirling, of Dundee, was next investigated at considerable length, and it was shown, that although its distinguishing feature, the "respirator" (or "regenerator"), was, both theoretically and practically, an efficient means of recovering the unproductive heat of an air-engine, the advantage was lost in the great back pressure against the working piston, and in the air which remained in the displacing cylinders.

Ericsson's new engine was next examined, and was shown to be the primitive air-engine, with the addition of Stirling's "respirator" (or "regenerator"), and it was argued, that while (theoretically) it was somewhat superior, it must (practically) be considered as much inferior to Stirling's engine; in consequence of the heated working cylinder, the low working pressure, which was shown not to exceed 11 lbs. average pressure upon the up-and-down stroke of the working piston, and the utter inadequacy of heating surface, which was limited to the bottom area of the working cylinder, and the passage leading to the "regenerator."

The latter defect applied also to Stirling's engine, and was accounted for by apparent misapprehension of the principle involved.

The duty to be obtained by the different engines, expressed in pounds lifted 1 foot high, for the unit of heat, or heat required to raise the temperature of 1 lb. of water through 1° Fahr., was shown thus:—

	Theoretical.		Actual.	In lbs. of Coal per H. P.
1. A theoretically perfect engine,	770	about	350	0·66
2. The Boulton and Watt condensing engine,	51·8	by rule	29	8·00
3. The best Cornish engine,	158	Pambour	82	2·82
4. The expansive air engine,	91	about	45	5·15
5. Stirling's ditto,	167	"	71	3·26
6. Ericsson's ditto,	196	"	60	3·86

In conclusion, the author referred to his own experiments and practical experience of several years, and enumerated the necessary characteristics of a machine, which, in his opinion, would constitute the most perfect engine, and with different applications of the "respirator" (or "regenerator.")

The paper read on May 24th, was "*A description of the Newark Dike Bridge, on the Great Northern Railway*," by Mr. J. Cubitt, M. Inst. C. E.

This bridge, for carrying the railway across a navigable branch of the River Trent, near Newark, was described as being erected at a point where the line and the navigation intersect each other, at so acute an angle that, although the clear space measured at right angles between the abutments was only 97 feet 6 inches, the actual span of the girders was 240 feet 6 inches.

The structure consisted of two separate platforms, one for each line of rails, carried upon two pairs of Warren's trussed girders; each composed of a top tube strut of cast-iron, opposing horizontal resistance to compression, and a bottom tie, of wrought iron links, exerting tensile force; these were connected vertically, by alternate diagonal struts and ties of cast and wrought-iron, respectively, dividing the length into a series of fourteen equilateral triangles, whose sides were 18 feet 6 inches long.

The top tubes rested upon the apices of equilateral or A frames, fixed on the abutments, and each pair of girders were connected by a horizontal bracing, at the top and bottom, leaving a clear width of 13 feet for the passage of the trains.

Each tube was composed of twenty-nine cast-iron pipes, of 1¼ inch metal and 13½ inches diameter at the abutment ends, increasing to 18 inches diameter with 2¼ inches metal at the centre of the span,—the ends of the pipes being accurately turned and fitted, so as to give exact contact of the surfaces, where they were connected together by bolts and nuts.

The lower tie consisted of wrought-iron links 8 feet 6 inches long, of the uniform width of 9 inches, but varying in number and thickness, according to the tensile strain to which each portion was subjected; the abutment portions having each four links of 9 inches by one inch, and the centre piece fourteen links of 9 inches by ¾ inch.

The diagonal tie links varied from 9 inches by 15-16 inch to 9 inches by ⅞ inch, and, in order to accord with the relative strains, were distributed in groups of four, for the first three lengths, on each side of the centre.

The cast-iron diagonal struts had a section resembling a Maltese cross; the area being in proportion to the compressive force to which they were subject.

The bearing pins at all the intersections were 5½ inches diameter, carefully turned and fitting into bored holes.

The links of the lower tie were supported, in the middle of each length, by a pair of wrought-iron rods, 1⅛ inch diameter, suspended from each side of a joint pin traversing the top tube; and by means of nuts and washers they could be made to bear a portion of the weight of the platform of the bridge.

The trusses were so arranged, that all the compressive strains were received by the cast-iron, and all the tensile force was exerted by the wrought iron; the proportion being such, that when the bridge was loaded with a weight equal to one ton per foot run, which considerably exceeded that of a train entirely composed of the heaviest locomotive engines used on the Great Northern Railway, no strain could exceed 5 tons per square inch of section.

The total weight of metal in each pair of girders, composing the bridge, was 244 tons 10 cwt., of which 138 tons 5 cwt. were cast iron and 106 tons 5 cwt. wrought-iron; which, with 50 tons for the platform, &c., made the total weight of each bridge 294 tons 10 cwt., or 589 tons for the whole structure; and the cost, exclusive of the masonry of the abutments, and of the permanent rails, but including the staging for fixing and putting together and the expense of testing, was £11,008.

In a series of experiments to test the stability of a pair of the trussed girders, at the works of Messrs. Fox, Henderson & Co., where they were constructed, the following results were obtained:—

With a weight of 446 tons regularly distributed, which was equal to 1½ ton per foot run, plus the weight of the platform, rails, &c., lowered seriatim on the thirteen compartments, the ultimate deflection in the centre was nearly 6⅞ inches.

With a weight of 316 tons, equal to 1 ton per foot run, plus the weight of the platform, &c., as before, the ultimate deflection at the centre was 4¼ inches.

When the bridge was fixed in its place, a train of wagons, loaded up to 1 ton per foot run, extending the whole length of the platform, caused a centre deflection of 2⅞ inches.

The deflection caused by two heavy goods engines, travelling fast, and slowly, was 2⅛ inches; and that produced by a train of five of the heaviest locomotive engines used on the Great Northern Railway, was 2¼ inches in the centre.

The proportions of the several parts of the structure were originally given by Mr. C. H. Wild (Assoc. Inst. C. E.), and had been only slightly modified by the author during the execution of the work.

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LIST OF PATENTS,

Issued from the U. S. Patent Office during the month of June, 1853.

Henry Baker, of Catskill, N. Y., for Converting Rotary into Reciprocating Motion.

Claim.—The ring, with its sliding pins attached to the object to which reciprocating motion is to be given, in combination with the stud, or its equivalent, attached to the endless chain, the points or ends of the said pin being caused to project through to the interior of the ring, to catch the stud or equivalent, and being withdrawn alternately, to allow it to pass, by springs, levers, and stops, as described.

T. A. Dugdale, of Richmond, Ind., for Washing Machines.

Claim.—Combining the wash-boards, cords, and floats, as described.

Henry W. Hewat, N. Y., for Propellers.

Claim.—Giving to the paddles, in their circuit, a greater longitudinal than vertical motion, imparted by a crank motion, as specified, in combination with the vibratory motion of a beam or beams, derived from the same crank motion, for the purpose specified.

Also, in the combination above specified, making the beam or beams slide on the fulcrum or fulcra, as specified, by means of which additional element, in the combination, I am enabled to impart to the paddle or paddles, the back motion, in the direction of the propelling action, more than the lower half of the crank motion, as set forth.

Wm. S. Hubbell & Amos Barrett, of Kingsville, Ohio, for Compositions for Treating Wool.

Claim.—Treating wool with a composition of oil and alcohol, to prepare and fit it for the several manufacturing operations, for which oil has been and is now employed.

S. P. Kittle, of Buffalo, N. Y., for Door Fastener.

Claim.—The construction of the bar, having the edges, with the stop or rest, having the lips constructed and arranged as described.

Also, the combination of the cap with the bar, the effect of the cap being to fill up the space between the edge of the door, when closed, and the casing, as described, all for the purpose and manner as set forth.

R. W. Belson, of Philadelphia, Pa., for Boilers for Cooking-Stoves.

Claim.—The employment of a valve, in combination with the escape tube of culinary boilers, such valve being controlled by the cover, or in any equivalent manner, as set forth.

Oliver Ellsworth, of Hartford, Conn., for Knob Bolts.

Claim.—First, the "Preventer" attached to the tumbler of the lock, for the purpose of preventing the bolt being forced inward, by means of any instrument from without, as described.

Second, I claim, in combination with the pin and spring, the oblique sides or angles, cavity or opening, made in the side of the case of the lock, for the purpose of converting my lock into a latch, or restoring the connection between the outer knob and spindle, by means of the rod pin coming in contact with the oblique sides, when the inside knob is turned, thereby turning the spindle and causing the rod pin to be moved out, by reason of the friction of said rod pin upon the sides of said cavity, as set forth.

Third, I claim the introduction of a key through a door knob, for the purpose of turning the spindle of the lock, thereby causing a lock to be converted into a lock (from the outside) as described.

Fourth, I claim the thumb pin or disconnecting pin, which passes through the outside knob, and into the spindle, thereby forming a connection with the rod, for the purpose of converting the latch into a latch at pleasure, from the outside of a door, as set forth.

R. J. Falconer, of Washington, D. C., for Hose Coupling.

Claim.—The employment of the slide coupling, in combination with the collars of hose, as set forth, by which I am enabled, in the case of water hose, to effect the coupling with the utmost facility, while the water is flowing through the hose.

P. G. Gardiner, N. Y., for Quartz Pulverizer and Gold Amalgamator.

Claim.—The arrangement of the vibrating, pulverizing basin and amalgamating basin attached thereto, with the screen interposed between the two, said basins being converted to the same shaft, and constructed and operating as described.

Herman Goldsmith, Jr., N.Y., for Water Closets.

Claim.—The annular water chamber at the upper part of the closet, with a valve so arranged as to open when the pan or basin closes, and allow a requisite quantity of water to pass around the sides of the pan or basin, and between the sides of the pan or basin, and the flange of the orifice, thus hermetically sealing the orifice, and preventing the escape of effluvia, said valve also closing, when the pan or basin is opened, and thus preventing the escape of water from the chamber, the valve being constructed of a sphere or ball, working over a circular opening in the bottom of the water chamber, or constructed in any other manner. I do not claim the water chamber independent of its valve, to operate as stated.

Leon Jarosson, of Jersey City, N. J., for Painting on Cloth.

Claim.—The painting upon cloth previously prepared with the mordant described, that will combine chemically with colors laid on, one over the other, and blended by means, substantially as described, by which I give great richness to the figures, whilst the tint of each is carefully preserved, and developing and fixing permanently the colors, by steam, and restoring the cloth to its natural pliable state, by washing out the excess of coloring matter, as described.

Gerard Sickles, of Brooklyn, N. Y., for Platform for Ferry Bridges.

Claim.—Applying or attaching to a ferry bridge or other boat landing, a movable platform, so arranged with any suitable mechanism, as to be operated upon by the boat, as it approaches the bridge, in such a manner that the boat causes the platform to move inwards and downwards, when the boat is coming into the slip, and the mechanism, or weights described, or their equivalents, cause the platform to follow the boat outwards and upwards, when the boat is leaving the slip.

Geo. W. Wight, N. Y., for Screw Presses for Packing Boxes.

Claim.—Bending the upper portion of the arms or levers from a vertical position, and tending towards each other until they reach and are joined to a cross piece or yoke, by joints, at any desired point between the centre of said yoke and the vertical portions of the uprights, thereby giving an oblique or inward direction to the hooks when the yoke is caused to rise, by the operation of a vertical screw.

Ebenezer Talbot, of Windsor, Vt., for Boring Rock.

Claim.—The method, as described, of applying a rollet cutter or cutters, for boring or excavating tunnels and other apertures in rocks or other hard substances, by causing the said rollet cutter or cutters, or sets of rollet cutters, to cut segments of circles from the centre, or near the centre, to the periphery of the tunnel, or other excavation, with the concavity towards the machine, in combination with a motion or motions around the centre of said tunnel, to cause the said cutter or cutters to act in succession, on the entire surface to be cut away, as described.

Julius Hornig & Ludwig Suess, of Union Hill, N. J., for Artificial Stone.

Claim.—The mode or process of forming artificial stone as described, that is to say, we claim the employment of silex, alumina, and salt, mixed and treated as set forth, and in the proportions, designated in the manufacture of artificial stone, meaning by salt the chloride of sodium, or its equivalent, as set forth.

H. L. Smith, of Cleveland, O., (assignor to H. L. Smith, of Cleveland, O., and Levi Buttles & H. A. Swift, of Ravenna, O.,) for Paper Files.

Claim.—The paper file described, with prepared adhesive leaves or margins, as a new article of manufacture.

L. P. & Wm. F. Dodge, of Newburg, N. Y., for Pumps.

Claim.—The combination of the cylindrical piston, constructed as described, with its valves and the induction and eduction passages, so that the water, all entering said cylinder, under pressure, alternately, at its ends, and being discharged under pressure, through the opening or openings, at its side.

We also claim the combination of the piston heads without the cylinder, with their valves, and the induction and eduction passages, when these valves are united (to insure simultaneous action), as described, the water entering through the piston heads, into the space between the same, and being discharged therefrom, through a lateral eduction orifice, the whole being arranged as described, thus dispensing with chambers and partitions, in the barrel and valves at the eduction port, preventing leakage, and rendering the pump or engine more simple and effective, and less liable to derangement.

C. B. Fitch, of Galena, Ill., for Cutting Tenons.

Claim.—The method described of cutting tenons by means of the scoring and V-shaped cutter that cuts the square shoulder and point, and at the same time scores the side of the tenon, when this is combined with the lancet-shaped or other finishing cutter, for removing the material left by the scorers, as specified.

Wm. G. Huyett, of Williamsburg, Pa., for Harvesters of Grain and Grass.

Claim.—The peculiar manner of arranging the two sets or series of knives, B and C, the knives, B, being of triangular form or saw-shaped, and having a reciprocating motion, and the knives, C, working directly over the knives, B, said knives, C, being attached by pivots to the outer ends of the teeth, and having an opposite reciprocating motion communicated to them, at their inner ends, by the lever and cross bar, by which arrangement a drawing cut is obtained and the knives effectually prevented from clogging or choking, by the grass or straw.

S. S. Jewett & F. H. Root, of Buffalo, N. Y., for Stoves.

Claim.—The combination, in a stove or grate, of the fire-place or furnace with a sliding door or doors, to close the front of the fire-place, and a recess in one or both of the jambs of the fire-place for the door or doors to slide into, and be concealed from view on the outside and be insulated from the fire and smoke within, this recess being a separate compartment open only where the door enters, and only of sufficient capacity to receive the same, as set forth.

Harvey Murch, of Lebanon, N. H., for Mop Heads.

Claim.—An improved mop-head, composed of the fixed cross-head, which has grooves in its lower side and end, in combination with the sliding binder that terminates in a notched shank, and passes through the loop on the handle, which serves as a detent in consequence of the action of the spring on the under side of the said shank, as set forth.

Geo. F. Muntz., Jr., of Birmingham, Eng., for Metal Tubes.

Claim.—The mode or process of manufacturing a metallic tube of Muntz's metal, or other like metal or composition of metals, viz., by first casting the metal in a short tube; next heating it as described, and rolling it flat, and elongating it at the same time; and, finally, opening it out and removing the surplus portions or fins, and reducing it to its final form in transverse section, as specified.

Lea Persey, of Patterson, Pa., for Self-waiting Dining Tables.

Claim.—A self-waiting table constructed and arranged as described, viz., having an endless band situated beneath the table and kept in constant motion during meals, by any power applied through the crank or other means, to which a band is firmly attached at convenient distances apart, guiding-carriers, &c., which pass up through, and are supported by small railway trucks, &c., and move in guiding apertures in the top of the table, and upon the tops of which are placed waiters, whereon dishes are put and constantly conveyed around before the guests on both sides of the table, in combination with the said endless band conveyers.

I also claim an additional shelf or second table, over the central portion of the table, above the waiters, for the purpose of holding castors, &c., which do not require to be frequently moved or replaced, as set forth.

Fergus Purden, of Baltimore, Md., for Mortising Machines.

Claim.—A divided bed, so constructed that it can be adjusted to suit the width of the mortise to be cut, so as to prevent the side of the mortise from being splintered by the cutter, or chips when they are forced through and driven out on the underside, as described.

A. H. Sampson, of New Orleans, La., for Brick Machines.

Claim.—The box or reservoir of platforms, with the carrying chains or their equivalents, provided with suitable projections for catching, drawing forward, and carrying immediately underneath the delivery follower the boards or platforms for receiving the pressed brick, and by which they are conveyed out of the machine, as described.

E. H. Smith, N. Y., for Copying Presses.

Claim.—First, the employment of the hand-lever to operate the pressing platen, through the agency, or by means of the sliding transverse bar, or its equivalent, in combination with the adjustable stop, or any other mechanical device substantially the same.

Second, the arrangement of the plates or platens, in such relation to their support and operating medium, as to render three of the four edges of each platen, unobstructed, perfectly available, and easy of access.

J. J. Sturgis, N. Y., for Type Casting Machines.

Claim.—The use of the horizontal mould block rest, in combination with the vertical and horizontal rock shafts and cam for the purpose of obtaining a motion of the mould block as nearly horizontal as practicable, as set forth.

Second, I claim the use of the lever and rod, in combination with the horizontal mould block, rest, and matrix, as set forth.

Third, I claim the use of the matrix-holder having a slot in it, to allow of a lifting motion on its centre pin, and a notch in its back side for the end of a spring to act against, in combination with the spring, inclined plane, or cam, on the horizontal rock shaft, and pin, for holding it, as set forth.

Fourth, I also claim the V-shaped bar, secured to an adjustable end plate, attached to the outer end of the lower half of the mould block, in combination with the upper half of the mould block, for the purposes set forth.

G. F. Filley, of St. Louis, Mo., for Cooking-Stoves.

Claim.—First, the flaring enlargement of the side flues, C and D, from the space above the oven, also the enlargement of the central flues, F and G, from the said flue space to the upper end of G, for the purpose of increasing the draught of all the flues and causing a larger portion of heat to be conducted into the flue space, as set forth.

In combination with the flaring shape of the flues C, F, and G, I also claim the auxiliary dumb flue which rises from the flue space to the hearth plate, and thence is continued immediately under the fire chamber and up the back of the same, by which another portion of heat from the fire chamber is conducted by radiation and circulation into the flue space, for the purpose of aiding in giving an increased draught to the stove, and in raising the temperature of the front end of the oven bottom to the required degree for baking purposes, as set forth.

Jas. M. Brookfield & E. V. White, of Honesdale, Pa., and Jacob Fautz, having been decided to be a joint invention with said White, the said Fautz & White, assignors to A. K. Hay & J. M. Brookfield, for Manufacture of Glass.

Claim.—The application of a blast, and anthracite coal as a fuel, in the manufacture of glass, as set forth.

J. L. Kingsley, N. Y., for Stereotype Plates.

Claim.—First, the process of expelling air from the surface of the type when forming the mould, and from the surface of the mould when forming the plate, as set forth.

Second, I claim the method described or its equivalent of dressing, bevelling or thicknessing the moulds and plates when made of gutta percha or compounds that run, so that all the plates made shall be invariably of the same thickness, as set forth.

J. J. Greenough, of Boston, Mass., for Manufacture of Plate Glass.

Claim.—First, manufacturing plates of glass by causing the glass while in a plastic state to pass between two or more pairs of rollers, as set forth.

I also claim embossing the surfaces of plate glass, by passing it between embossing rollers, as described.

And lastly, I claim suspending plates of glass by their upper edges, after they have been formed, while annealing, so as to keep them in a perfect plane, without resting on a bed.

Horatio Allen & D. G. Wells, N. Y., for Cut-off for Steam Engines.

Claim.—The mode of operating the loose toes by means of sectors combined with the rock shaft, and operated as described.

Benj. E. Colley, of Cambridge, Mass., for Pianofortes.

Claim.—Throwing the fly of the jack from the arm which operates the hammer each time the note is struck so as to permit its blocking in the said arm by the bent lever and set screw, operating independent of the hammer and hammer arm, in the manner set forth.

Wm. H. Danforth, of Salem, Mass., for Printing Presses.

Claim.—First, the employment in one printing press of two parallel type forms, one above the other, and two platens so arranged in a frame as that a sheet of paper can be printed by each form at one impression, as described.

Second, the mode of feeding the paper between the griping bars and bands, which hold it in place to receive the impression, and pass the sheet forward while the inking roller occupies the intermediate space to ink the type.

Third, making the feed-boards unequal in thickness, as described, for the purpose of furnishing an opening between the two sets, at the time that the sheets are to be entered from the tympan.

Fourth, the employment of a series of griping or discharging cross-bars, in combination with, and so arranged upon two endless bands as to be made to act upon the leading edges of the sheets as they pass along, and hold them against the feed bands until they have passed across over the top of the pile upon the platform, as shown, for the purpose of piling the printed sheets.

Fifth, the device for giving and checking the motion of the feed bands, alternately as required, consisting of the vibrating lever, bar, reciprocating rack, connecting wheel, two feeding wheels, fast wheel, or disc, spring pawl, adjustable cam, pin, studs, arm, rocking shaft, cams, pawls, brake, spring, and cylinder, arranged and operated as shown.

J. A. Elder, of Westbrook, Me., for Jacquard Looms.

Claim.—First, the arrangement of two trap-boards, placed the one above the other and between the suspension board and needles.

Second, two trap-boards, arranged the one above the other with their slots in opposite directions to the knot cord holes, when combined with the knot cords, having a knot for each board and a single set of needles for the purpose of vibrating the knot cords from the slots in one board to the slots in the other, as set forth.

E. L. Freeman, of Ann Arbor, Mich., for Bog-Cutting Cultivators.

Claim.—The precise construction of the tooth, and placed in the position as set forth, that is to say, the vertical part and the horizontal, each having a backward slant.

F. W. Howe, of Windsor, Vt., for Metal Planing Machine.

Claim.—Combining with the endless chain and the primary tool carriage, the two slide boxes, or their mechanical equivalents, the binders, rock lever, and its operative mechanism, viz., the rod, eccentric, shaft, and lever, or the mechanical equivalents of such rocker lever and operative mechanism; the whole being made to operate as described, and for the purpose of enabling a person to readily produce a movement of the tool carriage, either to the right or left, while the endless chain has a continuous motion in one direction, as set forth.

Wm. S. Hyde, of Townsend, Ohio, for Cultivator Ploughs.

Claim.—The cultivator, as described, with adjustable supplementary wings, so constructed as to cultivate the soil superficially near the roots of the plants, and deeper at a distance therefrom, the wings being adjustable to any required angle with the bottom of the furrow, so as to give any desired degree of inclination to the sides of the ridges or hills, and to change their inclination from time to time, to adapt them to the varying stages of the growth of the plant, as described.

Simon Ingersoll, N. Y., for Plug-Cutting Machines.

Claim.—The combination, as described, of the slide bar, I, having studs or projections, and the slide bar, J, having studs or projections, being all so arranged in relation to each other that the devices which move both slide bars longitudinally shall first give motion to the slide bar, for the purpose of forcing the dogs into the board or disc therefrom, previous to their retrograde motion for commencing a new feed.

J. H. Manny, of Waddam's Grove, Ill., for Cutters to Harvesters.

Claim.—A cutter, or sickle composed of a series of lozenge-shaped blades attached to a bar, as set forth, whereby the pressure of the grass on the front corners of the blade is so counteracted that the latter are not bent down from the edges of the guard-fingers against which they cut.

David H. B. Newcomb, of Conewango, N. Y., for Hill-side Ploughs.

Claim.—Arranging the two shares of a double plough, which alternately run forward on a central wheel, in such manner that the share, which for the time being is in the rear, shall be carried above the bottom of the furrow, as described.

I also claim the method of relieving the swivel and of steadying and supporting the beam when set, and in turning by means of a semi-circular guide or track, arranged and operating, as set forth, in combination with a catch at each end of the track to hold the beam in place when properly adjusted.

A. R. Pope, of Sommerville, Mass., for Electro-Magnetic Alarms.

Claim.—The combination of the movable or vibrating armature and the spring circuit-breaker, with the hammer of the bell, the same to be used in connection with the electro-magnet circuit wires and a key, as described, applied to a door or windows, the whole being made to operate together, as specified.

George Rohr, of Charlestown, Va., for Seed Planters.

Claim.—The invention, use, and application of a ridged or fluted or corrugated vibrating apron device, combined with the oscillating screen or grain scatterer, arranged with a crank-handle axis actuated by the pins or cogs on the scollop-like hob flange of the propelling wheel, together with the reacting spring-rest, as shown. The whole arranged and used together with a seed fountain, with apertures so constructed as to admit of connecting thereto short detachable or movable mouth-pieces, or outlet spouts, for the more perfect and free escape of the seed from the grain chamber or fountain, on to the apron and scatterer, specifically as set forth.

J. R. Shank, of Buffalo, Va., for Lath Machines.

Claim.—Imparting a vibratory motion to the gauge bar, in the manner described, so that it will not only perform the function of a gauge bar to regulate the thickness of the lath, but also that of a slipper, in order to insure the separation of the lath from the block, for the purpose described.

Walter Sherrod, of Providence, R. I., for Expanding Mandrels for Turning Machinery.

Claim.—A divided spring-shell constructed in the manner described, when it is combined with a tapering mandrel, so that by its own elasticity it shall retain its position on said mandrel, the whole arranged, constructed and combined in the manner set forth. Not meaning to claim the combination of a tapering mandrel, with a shell divided into more than one piece and tapering on its interior surface, being held on said mandrel by a spring clasp.

W. McK. Thornton, of Bloomsburgh, Pa., for Horse Collars.

Claim.—A horse collar formed with pad flaps, by the extension of the face leather of the pads as described.

I also claim the manner of stiffening and uniting the pads by means of a metallic bow, the ends of which are rigid to stiffen the shoulder pads and support the tugs, while its arch is flat, thin, and flexible in one direction, to allow the pads to change their relative distance apart, and comparatively rigid in the other direction, to prevent the pads from turning with respect to a plane parallel to the front of the collar.

J. H. Tuttle, of Seneca, N. Y., for Improvement in Saws.

Claim.—The combination, arrangement and location upon the same blade of the sets of fleam teeth for scoring the sides of the kerf, and the set of planing teeth for removing the wood between the scores when said planing teeth are placed back to back, curve in opposite directions, and are between the sets of fleam cutters, and at sufficient distances apart, so that each planing tooth shall serve alternately as a gauge to its fellow, while allowing it to cut to a proper depth and be a permanent guide to the fleam cutters, to prevent any of the teeth from taking too rank a hold upon the wood, which makes it run with great ease and efficiency, and is applicable to slitting or cross-cutting, as described.

J. B. Wilder, of Belfast, Me., for Hill-Side Ploughs.

Claim.—Having the mould-board so constructed, arranged and attached to the share, and land side plate, that said mould-board may be turned, as set forth, independently of the share, and a proper curved outer face be presented to the sod, on either side of the plough, the mould-board being constructed with two faces precisely of the form shown.

B. R. Norton, of Syracuse, N. Y., for Metallic-Pointed Pens.

Claim.—A metallic-pointed pen attached to a wire of the length required to form a handle or holder, when such pen and holder are covered from the top of the holder to near the nib of the pen by a coating of gutta percha, or india-rubber of suitable thickness, made in the manner set forth.

Wm. F. Tysoo, of Orwigsburgh, Pa., for Propellers for Canal Navigation.

Claim.—The blades constructed with lips or rims, which are sections of a cylinder concentric with the axis on which the propeller rotates, as specified.

Enoch Hidden, of N. Y. City, for Side Lights for Ships.

Claim.—The arrangement of screws tapped into the main frame, in combination with inclined planes or spirals, forming part of said screws that holds the light frame, or cell containing the glass, fast to the india-rubber in its grooved seat, in the main frame with its stop pin, for stopping the screw in its proper position, when the light is to be opened for ventilation.

I also claim the projecting ears, with slots or chase mortises, in which the pivots of the light frame or cell turns, allowing the light to be hauled from its seat, and consequently out of contact with the india-rubber, so as to allow the plane of the light to be placed at any angle to the main frame, thus freely admitting of ventilation.

I also claim the arrangement of a lead or other ductile metallic ring, soldered on, otherwise joined to the main brass frame of the light, so that it can be turned round the outer edge of the opening in the vessel, securing any suitable material completely, making the main frame of the light water-tight to the vessel, as set forth.

R. L. Hawes, of Worcester, Mass., for Envelope-Folding Machines.

Claim.—First, the combination of the self-adjusting feed-table, with the paste fountains, so arranged as that they will descend and press a freshly-pasted surface of their rollers upon the top sheet, and raise it to permit the table to pass beneath and take away a sheet at every second revolution of the main shaft.

Second, I claim the combination of the platform with the hooks, and the retaining fingers, and the fingers for discharging, for the purpose of properly conveying and discharging the sheet or envelope.

Third, I claim the combination of the platform with the follower or first presser, and its weight or retainer, as described.

Fourth, I claim the finishing folder, consisting of knives, with their adjustable springs and guides, in combination with the finishing plunger, to press the envelope and cause the three flaps to adhere together or one to the other.

Fifth, I claim the arrangement for raising the table, in combination with the fingers, for discharging finished envelopes.

B. H. Bartol, of Philadelphia, Pa., for Refrigerators for Cooling Liquids.

Claim.—The arrangement of the series of partitions and interstices, for cooling water, as set forth.

Horatio Clarke, of Dedham, Mass., for Bobbins.

Claim.—The making the bobbin-head as described, viz., of a combination of wood and raw hide, or other material having like properties, whereby the head is not only cheaply constructed, but rendered properly stiff and capable of resisting the effects of blows, falls, or wear, as stated.

Christr. Duckworth, of Thompsonville, Ct., for Shuttle-Box Motion in Looms.

Claim.—The method of giving a three-fold movement (lateral, vertical, and diagonal) to the shuttle-boxes, as described, by which I am able to operate any required shuttle at any given pick.

I also claim the apparatus for operating the shuttle-boxes, consisting of the case, with its friction rollers and slides, combined with the levers, which work the slides, and the principal lever which moves the shuttle-boxes, when the whole is constructed, arranged, and combined as described.

H. N. Goodman, of New Haven, Ct., for Melodeons.

Claim.—The two sets of reeds with the two sets of keys, when these are combined with the two sets of valves, and so arranged that each set of keys may play their own set of reeds independently, or, so that the lower set of keys may play both sets of reeds (in the ordinary way of two stops), while the upper set of keys may play its own set of reeds only in any other part of the key board, at the pleasure of the performer, when constructed and combined as described.

I also claim the method of coupling or connecting the lower set of keys with the back set of valves, so that both sets of reeds may be played by the lower set of keys, when the several parts are constructed, arranged, and used as described.

D. H. Hovey, of Kilborn, Ohio, for Twisting Waxed Ends.

Claim.—The combination of the revolving rollers or tubes, conical coupling cores, the spring tightness, with the detaching levers, arranged and operated as described.

Edmund Morewood & Geo. Rogers, of London, Eng., for Coating Zinc with Lead.

Claim.—We are aware that metals have been coated, one with another, by washing and plating, to protect them from oxydizing agents, &c., but we are not aware that zinc and lead have ever been united and rolled into united laminal of each of these metals, as described. Therefore, we claim such a composite sheet as a new and useful manufacture, or article of merchandise or trade, of great value and importance, and which possesses the hardness, stiffness, and strength of zinc, with the capacity of lead, to resist the action of oxydizing agents, as set forth.

L. S. Reynolds, of Indianapolis, Ind., for Bran Dusters.

Claim.—The employment of the conical roughened metallic scourer, in combination with the double disc rubber, the discs and pins of which always preserve the same relative position, being arranged as set forth.

Christian Sharps, of Hartford, Conn., for Percussion Pellets.

Claim.—The percussion pellet, consisting of a quantity of detonating material, inclosed between two flanged discs, or shallow hollow cylinders closed at one end, the open end of one cylinder being fitted into the open end of the other, and the two being firmly interlocked, by crimping together their flanges, rims, or peripheries, as described, so as to form a pellet in the form of a disc.

E. E. Shepardson & Edwin Lucas, of New Bedford, Mass., for Tuning Melodeons and other Reed Instruments.

Claim.—Securing or attaching the reed to a movable pipe or tube, the reed being arranged or placed between stationary clamps, by which, as the pipe or tube is moved, the vibrating portion of the reed may be lengthened or shortened, and the desired tone obtained, as described.

Lauren Ward (administrator of Richard Ward, deceased), of Naugatuck, Ct., for Turning Irregular Forms.

Claim.—The combination of the jointed levers, suspended by their upper ends with the crank and connecting rod, when so constructed and arranged as to elevate or depress the inner part of the carriage, and the toothed centre, in such a manner as to give a regular elliptical form to the polygon where the opposite longitudinal sections will be equal and similar when the whole is constructed, arranged, and combined, as described.

I also claim the use of the notched collet, on the toothed cutter, and the carved bar, in combination with the jointed levers, to give regular and irregular forms to different parts of the same elliptic polygon, when the whole is constructed, and combined, as described.

James Foster, Jr., & Platt Evens, Jr., of Cincinnati, Ohio, for Metallic Boxes for Presses, &c.

Claim.—The mode of preventing the shrinking and binding of metal bushings when cast up on screws, mandrels, spindles, shafts, and the like, by the insertion of feathers either movable or fixed in the boxes to be bushed, for the purpose of separating or breaking the ring of bushing metal, for the purpose set forth.

Amzi C. Semple, of Cincinnati, Ohio, (assignor to Wm. C. Semple,) for Presses.

Claim.—Sustaining the gear frame of a double toggle press, by the toggle arms and joints, independent of and disconnected from the frame of the press, by attaching the same firmly to the nut, as described, in combination with supporting the screw by the nuts thus sustained, only the whole being arranged as described.

N. B. Lucas, of Otter Creek, Ill., for Threshers and Separators of Grain.

Claim.—The auxiliary screen, placed in an auxiliary position, or nearly so, and projecting from the rear end of the inclined screen, so as to be out of the axis of the blast over the inclined screen, for the purpose of catching and saving the blighted and lighter kernels of grain which may be blown beyond the rear extremity of the said inclined screen, as set forth.

RE-ISSUES.

Moses Pond, of Boston, Mass., for Cooking Ranges. Patented Feb. 25, 1853.

Claim.—The improvements by which the hot water back is connected with the plate, and by means of which said hot water back may be either readily removed, at any time, or applied in such manner that the directions of its water pipes may be disposed, so as to accommodate the bath boiler, into which they are usually led, on whatever side of the range the said bath boiler may be placed; the said improvements consisting, first, in the connecting piece, and the attachments of it, and the hot water back, the whole being made to operate together, as set forth.

Second, in a second set of attachments (fixed on the opposite face of the water back) in combination with the first set thereof, as described.

I also claim the peculiar arrangement of flues, which lead the smoke and volatile products of combustion directly around the oven, the said arrangement of flues causing the heat to course against a portion or one-half of the bottom of the oven; next into another flue, which takes it backwards and against the other portion or half of the bottom of the oven, thence up a flue against the oven, thence through a flue extending over and against a portion or half of the top of the oven, thence into and through another flue, which carries it backwards and over and against the top of the oven, and conveys it to the chimney or discharge-flue, not meaning to include in such arrangement the radiating chamber or space.

I also claim the two recesses and two flue plates applied to another plate, in combination with the two valve openings, their damper and cover plate, as applied to the top plate of the oven frame, and used under an arrangement of oven flues, substantially as described, the same allowing of the adaptation of the oven, to either side of the fireplace, or the use of two such ovens and their frame, in connection with the fireplace, as stated.

I also claim the improvement by which the oven can be raised and readily removed, and by which the smoke is prevented from passing underneath the partition which separates the flues on the top of the oven, the same consisting in the sliding or gravitating plate affixed to the partition and made to operate, as specified.

Patrick H. Devlan, of Reading, Pa., for Lubricating Compound.

Claim.—The combination of caoutchouc or other similar gum, with animal or vegetable oil or fatty matter, as specified, applicable as a substitute for oil in lubricating machinery and for other purposes.

J. A. Bowie & Charles Carr, of Philadelphia, Pa., (assignees of Robt. B. Goodyear,) for Apparatus for Operating Shuttle-Boxes of Looms. Antedated Sept. 13, 1848. Re-issued June 14, 1853.

Claim.—The employment for the purposes of weaving, of an index plate, having movable and adjustable pins projecting at different distances from the face of said plate, in combination with the shoe, or its equivalent, having projections corresponding to the different length of pins, for the purpose of raising and falling, the shuttle-boxes to correspond with the pattern desired to be formed, as described.

A. T. Serrell, of N. Y. City, for Mouldings. Patented May 16, 1848.

Claim.—First, the combination of the ring or rings with a cutter or cutters for operating on an angular strip for making a moulding; whether the said cutter or cutters be rotating or stationary, or both, and whether the said cutter or cutters operate on the face or on the edge of the strip, or on both the face and the edge, as described.

Second, the combination of the adjustable bed with the ring or rings and a cutter or cutters, as aforesaid, for operating on an angular strip for making a moulding; whether the said cutter or cutters operate on the face or on the edge of the strip, or on both the face and the edge, as described.

Walter Kidder, of N.Y. City, for Gas Regulators. Re-issued June 28, 1853.

Claim.—Balancing the varying pressure of the gas in the main by connecting with the valve a disc, which receives pressure from the main to balance the pressure on the valve, as described, or the equivalent thereof, in combination with the method described of governing the aperture through which the gas passes to the branch of the varying pressure of the gas beyond the valve which governs the aperture, as described, so that when the pressure becomes too great, the aperture shall be reduced, and *vice versa*.

And I also claim, in combination with the above, making the disc so that it shall be also acted upon by the varying pressure in the branch to assist in moving the valve to govern the aperture for the passage of the gas, as specified, whereby the action of the instrument is rendered more sensitive and prompt as a governor.

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The late Gallant Performance of the Arabia.

Since our last issue the world has been apprised of an extraordinary quick trip by one of the English line of Liverpool steamships. The fact is indisputable. The British and North American Royal Mail Steamship "Arabia," in the month of June, 1853, crossed the Atlantic Ocean in less time than any other floating object since the discovery of America, *excepting the United States Mail Steamship "Arctic."* As an interesting matter for permanent record, we append the time of both these trips, and the average of all the trips, and there leave for the present the discussion of this highly interesting competition. It will be seen that the difference in the brag trips is very inconsiderable, but that in average speed the Collins line are indisputably far in precedence.

Differences of opinion may exist as to whether the docks, the outside lights, or some other points should be considered the beginning and end of the voyage; also, whether the reckoning should be in true or apparent time. On the latter point there is really no room for dispute, real time being, too plainly, the only just standard for comparing a number of voyages in different directions. It chances, however, that the *quick* trips in question are both in the same direction and unaffected anywise by this decision. The difference in time between the two cities is 4 hours, 48 minutes.

On the other question parties may, perhaps, contend for such points as suit their convenience, but general consent indicates the Battery at the lower end of this city, and Rock light, near the other extremity of the route, as the proper termini of the struggle in every instance. Measured by this standard, the quick trips will, on the authority of Chief Engineer, Daniel B. Martin, U. S. N., (probably the most active and reliable individual connected with the personal supervision of this gigantic race,) compare as follows:

ARCTIC. Passed the Battery at New-York, Saturday, Feb. 7th, 1852, at 12 15, m.; arrived off Rock light, Liverpool, on Tuesday, Feby. 17th, at 10 10, a. m. Apparent time, 9 days, 21 hours, 55 minutes. Clock time, 9 days, 17 hours, 7 minutes.	ARABIA. Passed the Battery at New-York, on Wednesday, June 15th, 1853, at 12 35, m.; arrived off Rock light, Liverpool, Saturday, June 25th, at 10 34, a. m. Apparent time, 9 days, 21 hours, 59 minutes. Clock time, 9 days, 17 hours, 11 min.

As is frequently the case with the ships of her line, the Arabia had previously hauled out into the stream, taking in her latest passengers and mails from smaller steamers alongside. On the occasion in question, the 15th of June, the Arabia had steamed a short distance of the river, turned, and had actually passed the Battery some half-mile or more, on her way down the harbor, before taking her latest mails. It is from this point she was timed, giving her in effect from 2 to 5 minutes advantage over the Arctic. Critically, the Arabia lacks about 7 minutes of equalling the best trip of the Arctic; this, in a passage of nearly ten days is decidedly close running.

The average passages of all the ships of both lines, during the year 1851, and the first eleven months of 1852, were published in the New-York Herald of January 1, 1853, probably on the authority of some parties connected with the ship news department of that paper, and compare as follows:

	1851.		1852.	
	To Liverpool.	To New-York.	To Liverpool.	To New-York.
Collins line	11d 3h 16m.	11d 12h 12m.	11d 1h 47m.	11d 5h 24m.
Cunard line	11d 1h 28m.	12d 5h 11m.	11d 7h 38m.	12d 11h 42m.
Difference	1d 48m.	15h 59m.	5h 51m.	1d 6h 18m.

The first difference is *against*, the remaining three are *in favor of* the Collins line. The *mean* difference is 12 hours, 35 minutes, in favor of the Collins line.

We disclaim any intention of distorting the facts, and except a reasonable degree of national pride, have no interest whatever in the result. We think the above can be depended on, as strictly reliable and satisfactorily establishing the claim of the American steamers as habitually the fleetest vessels.—The Arctic's passage in the spring of '52 is yet unsurpassed. How soon the immense engines of the Arabia, or the still more gigantic Persia, will change the relation of the two lines, remains to be developed.

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Written for Appletons' Mechanics' Magazine.

Mechanics for Practical Men.—Strength of Materials.

BY CHARLES A. LEE, C. E.

All solid bodies are proved to be possessed of certain general properties, among the most important of which is the capability of offering resistance to forces tending to change the relative position of their particles. It is this that it is proposed to discuss.

There are different hypotheses as to the ultimate arrangement of the particles of bodies, but for estimating the strength, it is customary to suppose them to be made up of fibres running parallel to the length of the body; which fibres are more or less elastic, and capable of being extended or compressed within a certain limit, which is called the "limit of elasticity." The amount of compression, or extension, is directly proportional to the force applied, and to the length of the piece, and inversely proportional to the transverse section. It must be understood, however, that these changes of form are very minute, depending on the nature of the material in question.

Moreover, the same force will produce equal extensions and compressions in the same piece. Suppose we take a bar of iron and bend it, it is evident that the fibres on the convex side are lengthened while those on the concave side are shortened. It is the natural elasticity of these fibres that causes the bar to spring back when the pressure is removed. If the bar is bent so much, and consequently the fibres extended and compressed so much, as to exceed the "limit of elasticity," the bar will not return fully to its original form, but will take what is called a permanent "set." When a piece is submitted to a strain sufficient to give it a permanent set, it will from that time, if the force is continued, undergo a gradual yielding until finally it gives way. This gradual yielding sometimes takes months and years to be sensible; but experiments have proved that it does take place. After the natural elasticity is once destroyed, the piece if the charge is continued, keeps growing weaker. It is thus seen that in practice it is absolutely out of the question to submit materials to a greater strain than that corresponding to the limit of elasticity. And it should never ordinarily exceed from [illegible] to [illegible] of this limit. There will be given, farther on, practical rules for guidance in this respect.

There are several species of strains to which materials may be subjected,—compression, extension, torsion, transversal strain, and detrusion, or where the force acts at right angles to the fibres.

When a solid is subjected to a strain sufficient to cause rupture, either by crushing or extension, it is proved by experiment that the force necessary to produce this effect is directly proportional to the transverse section of the body, that is, to the area of the section. There will be found in the Table the ultimate resistance of different kinds of materials to extension and compression; but it must be remembered that these experiments were made on fair sound specimens, and under favorable circumstances, and that the pieces subjected to compression were but once and a half their base in height. When the specimens exceeded six times their base, they gave way by bending.

Explanation of the Table, No. 1.—The first column gives the different materials. The second gives the weight of a cubic inch or foot of each in pounds. The third gives the weight necessary to rupture by extension a piece one inch square. The fourth gives the same with regard to compression. The fifth and sixth give the limits which should not be exceeded in practical applications, in pounds per square inch of section.

MATERIAL.	Weight of a cubic foot in pounds.	Ultimate resistance to extension per squ'e inch of section.	Ultimate resistance to compression per squ're inch of section.	Limit which should not be exceeded in practice. Extens'n.	Limit which should not be exceeded in practice. Compression.
Ash (English),	47.5	17000	9000	1000	1000
Beech (do.),	43.8	11000	12000	"	"
Box,	62.5	20000	12000	"	"
Elm,	33.8	5800	10000	"	"
Fir (New England),	34.4	12000		"	"
" (Riga),	47.0	12600		"	"
Larch,	33.8	7000	4000	"	"
Locust,	59.5	20500		"	"
Oak (English),	50.0	12000	8000	"	"
" (Canadian),	54.5	12000	5000	"	"
" (Dantzic),	47.5	14500	7000	"	"
Pine (pitch),	41.2	10500	6700	"	"
" (red),	41.3	10000	7500	"	"
Teak,	47.0	15000	12000	"	"
IRON.	Weight of a cubic inch in pounds.				
Bar 1 inch square (Welch),	0.281	58000	70000	10000	15000
2 inch round bar,	"	59000	"	"	"
Russian 1 inch round bar,	"	58000	"	"	"
Swedish 1 inch square bar,	"	58000	"	"	"
American bar iron,	"	48000	"	"	"
English cable iron,	"	53000	"	"	"
" hammer hardened,	"	68000	"	"	"
Iron Wire.					
1-8d inch diam. Philipsb'rg,	"	75000		12500	
0.19 " " "	"	66000		11000	
0.156 " " "	"	80000		13300	
0.1 " English,	"	72000		12000	
Boiler Iron (American).					
Piled iron,	"	56000	70000	9800	11700
Hammered Plate,	"	55000	"	9100	"
Puddled iron,	"	51000	"	8500	"
Cast iron,	0.26	18000	80000 to 150000	3000	13000 to 25000
Wrought Copper, in sheets,	0.32	30000	100000	5000	16000
Cast Copper,	0.317	17000	117000	3000	19500
Copper wire,	0.32	60000		10000	
Cast Tin,	0.268	4200	1000	700	170
" Zinc,	0.248	8400		1400	
Rolled Zinc,	0.25	7000		1170	
Cast Lead,	0.41	1700	488	300	80
Rolled Lead,		1800		300	
Yellow Brass,	0.282	16000	108000	2700	17000
Gun metal,		32000		5300	
Granite,	0.097		10000		1000
Sandstone,	0.088	800	5000	80	500
Limestone (Magnesian),	0.115		5000		500
Oolites,			2000		200
Limestone (Silicious),	0.114		5000		500
Hydraulic lime mortar,	0.055	140	500	15	50
" cement,	0.056	234	700	25	70
Ordinary lime mortar (old),	0.058	70	500	6	50
Best quality Brick,	0.069	280	2000	30	200
Inferior "	0.062	100	800	10	80

The preceding Table has been prepared from the highest authorities, Morin, Poncelet, Claudel, Barlow, Hodgkinson, Franklin Institute, and others, and the utmost reliance may be placed upon it. It has been prepared especially for the *practical use* of American mechanics. The numbers in the fifth and sixth columns are those recommended by the most eminent engineers and practical men, both in this country and Europe.

With regard to the absolute ultimate strength of materials, it is proper to state that they vary very much for different specimens of the same material. This applies more especially to wood, but also in some degree to all substances. It depends much on the state of the specimen. For instance: in the following table will be found the result of experiments made on short cylinders of timber with flat ends, subjected to a compressive force. The cylinders were one inch in diameter, and two inches in height; the results in the first column were obtained from timber moderately dry, those in the second column were obtained in like manner from similar specimens which were turned and kept in a warm place two months longer. A comparison of the two columns will show the great importance of having timber thoroughly seasoned, in order to obtain its full strength.

DESCRIPTION OF WOOD.	Strength per square inch in pounds.	
	Green.	Dry.
Ash,	8683	9363
Beech,	7700	19800
Birch,	8900	11600
Oak (Quebec),	4280	6000
" (English),	6480	10000
Larch,	3200	5560
Willow,	2898	6128

With regard to the safe amount of strain it is proper to charge materials with in constructions, the engineer will be guided in each particular case by his judgment. It is impossible to give rules for every case. If, for instance, a piece of timber is to occupy a position where the strain upon it is steady, and it is exposed to no abrasion or decay, supposing it to be a fair sound specimen, it might be submitted safely to a strain as high as one-sixth or one-fifth of its ultimate strength. But ordinarily this would be too high. The French *mecaniciens*, Poncelet, Morin, Claudel, and others of the highest authority, have agreed upon certain limits to be used in practice for all kinds of materials, and which will be given below. This limit for wood is one-tenth the ultimate strength. This is the same ratio recommended by Haupt in his work on Bridges, and which he found to be perfectly successful in practice, as combining a judicious degree of strength with the least quantity of material.

As the mean ultimate strength of wood may be rated at 10,000 pounds per square inch of section, both for compression and extension, we have for our practical limit, not to be exceeded in ordinary cases of construction, 1000 pounds per square inch. Where timber is exposed to other than the legitimate strains due to its position in the structure to which it belongs, and which we will show how to calculate farther on, the engineer must of course use his judgment, unless these outside forces are such as to be calculated. The limits spoken of above, are for wood, stone, and mortars, one-tenth their ultimate resistance, both for extension and compression; and one-sixth for metals. As M. Poncelet has remarked, it would be more proper to determine these limits from the limits of elasticity of the several bodies, but experiments on this point have been made in but few instances.

Correspondence.

[For Appletons' Mechanics' Magazine.]

On Warming and Ventilating Houses.

No. 2.

(*Continued from page* 167.)

From the foregoing observations, it can readily be deduced, that not only should the chimney afford a direct and unobstructed passage for the heated gas and smoke, untrammelled by soot and free from bends and twists, but that the pipes, or other communications leading from the fire-chamber of the stove or furnace, should be short, direct as possible, and of sufficient size to exhaust suitably the gas and smoke-forming capacities of the combustion. If circumstances render crooks and turns necessary, they should always be made in an *upward direction*, so as not to interpose the additional obstruction of a *descent*, for heated products, which is totally at variance with their nature. The idea of getting useful warmth from the smoke and gas, by making them descend and ascend several times through metallic pipes or columns, before they are allowed to reach the chimneys, is absurd, unphilosophical, and practically false. Every foot of metallic flue through which they traverse only enfeebles their levity the more, to say nothing of frictional obstruction. Puzzled in their attempts for freedom, they seek the ready outlets of cracks and joints, thus poisoning the air with their deadly vapors, and unfitting it for healthy respiration. Most of the forms and designs of stoves at the present day are constructed upon this false principle. The Patent Bureau should positively refuse to issue patents for such life-destroying machines, as by law it has the power to do, no matter how praiseworthy the rest of the invention may be.

One of the largest hot-air dealers in this city, in a recent conversation, prided himself upon manufacturing a form of furnace that caused at pleasure what he termed "slow combustion," by dampers, that compelled a repeated descent and ascent of the gas and smoke. He assured the writer, that by this device a great saving of fuel was accomplished; and so much did he esteem it, that he paid one or two dollars to the patentee for the right to use it on each furnace manufactured. So, too, another very popular form of stove, usually sold to be placed in basements, or lower stories, and having a pipe or flue for hot air opening and leading to the parlor above, is provided with similar dampers or valves, that compel, at pleasure, an unwilling and enfeebling descent of the gas and smoke. A visit to any of the stove warehouses, and an examination of the patent-office records relating to this class of inventions, will satisfy the curious that death-dealing apparatus of this kind is now, and has been for many years, the most popular and extensive in use; and proceeding on fallacious and unphilosophical principles, the manufacturers and dealers have speciously compelled their entrance into the market, and from thence into daily use. There are but few stoves in use now that are not provided with dampers in the pipes, which are often closed, sometimes by ignorance or neglect, but oftener by design, thus causing the subtle gases generated by combustion to pour their deadly vapors into one or more inhabited apartments.

The great mistake hitherto has been and now is, that the attention of inventors of this kind of apparatus has been mainly directed to the development and elaboration of the caloric contained in the gas, smoke, and other volatile products of combustion, and its application and adaptation to useful purposes, instead of to the true and proper inquiry as to the development and elaboration of the caloric contained in the combustion itself. Hitherto, the fuel has been left to burn itself quietly away in immense masses, walled up in metallic brick-lined fire-chambers, having no breathing outlet save the labyrinthine stove-pipe, full of ingenious valves and dampers. It was foolishly supposed that a wonderful economy in fuel would be realized, if the caloric could only be extracted from the passing gas and smoke, before their entrance to the chimney, and radiated and employed for useful purposes. So, too, a very extensive inquiry has been instituted into the policy and economy of burning the smoke, and numerous clever though expensive devices in this behalf have been invented, patented, and brought into daily use. Perhaps this last inquiry is not entirely an improper one, and it may finally be attended with some useful results. Its consideration, however, appears to be secondary, in comparison with the great question, How shall the caloric contained in the glowing, burning mass of coals be best elaborated and developed?

Suppose that one of the largest buildings should have every window, door, and other air aperture, perfectly and hermetically sealed, save a single chimney, and that an ordinary stove or furnace stood in one of the rooms, having a short, direct, unobstructed pipe to the chimney; suppose, too, that by means of a fan or blower, or other suitable device, every particle of air in this immense building should be successively compelled to pass through a hollow heated pipe, or into suitable contiguity to or contact with the fire, or some surface heated by the fire, without, at the same time, increasing, or in any way affecting the draft of the fire, which is allowed to go on in the usual manner,—it would be found, after the entire mass of air had thus passed, and had thus become warmed, that the fire would be itself but little lessened, and if at all, only to the ordinary extent. And yet a wonderful amount of heat, usually concealed, has been developed; an immense quantity of air has been heated; the smoke and gas, too, have escaped freely, and without obstruction to the chimney; the air of the building from top to bottom has been warmed, and still the *quantity* of the fire is but little diminished. This reveals to us a fact, which, in these latter days, seems entirely overlooked, that there is in combustion caloric of enormous capacities; heat and power that might be usefully employed and developed under suitable organizations of heating apparatus. It is to this subject particularly that the attention of the ingenious and the philosophical should be directed.

There is really enough caloric or heat, if developed, in a mass of glowing coals, say of ten inches diameter by as many deep, to heat almost an atmosphere under suitable circumstances and with suitable apparatus. The inquiry then should be, How can we get this heat out? How can it be developed? And yet how much time, and philosophic patience, and learning have been thrown away on the purely secondary thought of making the stove or furnace burn its own smoke! or the still more absurd thought of endeavoring to extract the heat from the gas and smoke before their entrance to the chimney, by obstructing their passage, and surrounding them with high conducting mediums. For devices of this kind, thousands of patents have been granted, and continue to be granted both in this country and Europe. The public have been choked and sickened by foul vapors, and leaky, complex, and obstructed stoves. Constrained by necessity, they have of late favored the kind of heat elaborated from steam or water, and have introduced hot-water apparatus into their houses, even at enormous expense; the latter an item little to be considered, however, where the health of a family is concerned. And if, indeed, there was not a remedy for the present abuse of hot-air apparatus, the public would be justified in resorting to hot-water devices; for with the latter, they are at least assured that noxious gases shall not be generated and disseminated in their chambers. The introduction of hot-water apparatus was a worthy step from the wretched imposition of the quack stove-dealers, who might be aptly termed public poisoners.

But this kind of furnace is too expensive. It can only be afforded by the affluent. It involves, perhaps, a rebuilding or alteration of the house. It requires, perhaps, a certain amount of study to prevent accident. Is there no plan that can be submitted to the sound judgment of the people that will provide for us suitable and adequate heating apparatus, accessible to the scanty purses of the poorest members of society, and that will do away with the evils and defects which have just been alluded to?

As long as the fire burns, and currents of air freely passing through the grate supply oxygen, just so long will smoke, gas, and other volatile products, be evolved and generated, and all the wit of man, or all the inventions in the world, will never alter the constituent qualities of the fuel, or lessen the quantity of the generation of its gases, when elaborated by combustion. Smoke, which is a ponderable combustible body, may undoubtedly be burned; but the device used in accomplishing this result may be more expensive than profitable, and the serious obstruction afforded by the smoke-burning apparatus to a free escape of deleterious gases to the chimney or open air, may more than off-set the little benefit derived from its consumption as a fuel. If slow combustion is desired, reduce the admission of air to the grate, diminish the draft, but do not allow a free admission of oxygen to the fire, and then obstruct the smoke and gas necessarily evolved, as the result of combustion. Reform the cause before undertaking to modify and control the effect. Why, then, not open free pipes to the chimney? Why torture and twist them into an endless variety of shapes, through an endless variety of rooms? and why enfeeble the levity of the smoke by ascents, descents, and the contiguity and contact of conducting and absorbing mediums?

The writer can point to a famous style of furnace (famous, perhaps, through the advertising industry of the manufacturer, rather than by its own merit), where the patentee, in a pamphlet of written directions, instructs the purchaser in the method of using the numerous dampers interspersed through his pipes, fallaciously reasoning that in that way the "slow combustion" so much sought after can be obtained. And yet this furnace obtained a prize medal at the World's Fair! How is it possible to have *pure* warm air, when such directions are followed? and what is to be said of the good sense of the age, or of its scientific research, when prize medals are awarded to such apparatus? But this furnace does not stand alone. There is hardly a stove or other heater in the market, or in use, but what is similarly provided with smoke-pipe dampers, while that part of the apparatus appertaining to the admission of air to the fire is badly, unphilosophically, and carelessly constructed. In nine cases out of ten, even in what are called *air-tight* stoves, the quantity of air to be supplied is incapable of any adjustible regulations at all.

How much patient and expensive labor has thus been spent, how much research has thus been thrown away, in pursuit of an absurdity? how much ingenuity has been wasted on smoke-burning devices, while the fire itself, and the great heat contained therein, has been left to burn itself away quietly! If air-warming metallic superficies is desired, why not have it? Will not the fire heat a much larger metallic air-warming surface? Would it not, if placed under a large caldron of water, heat the same in time, almost, if not quite to the boiling point, even though the caldron should be one hundred times the size of the fire, and its contents a slow conducting medium like water? Or would it not, if placed suitably in the centre of a metallic mass one hundred times its size, soon heat the entire mass, and yet remain substantially as undiminished in volume or quantity as it would when placed in an ordinary stove? These inquiries, therefore, force upon us the conclusion, that an ordinary stove-fire has capacity enough to heat an enormous amount of conducting and radiating masses. Increasing the metallic air-warming superficies is attended with great expense, which is an evil sought to be remedied. So at least we are told. But is this so? Cannot human ingenuity devise a cheap way of producing large air-heating surfaces? If a small fire will heat a large metallic mass, the inference necessarily follows, that if this heated conducting mass is suitably exposed to the air, or so that the air of the room may come within its heating influence, by contact or otherwise, certainly such air will become itself heated, and the end and aim of all these devices satisfactorily accomplished. The rule is, that the greater the extent of heated conducting and radiating air-warming superficies, the greater the amount of air will be warmed, and rendered competent for useful purposes.

It may be said, however, that all the stoves and furnaces of the present day follow in their construction that precise rule. Have they not all external heated air-warming surface? Are not pipes, tubes, cylinders, columns, figures, grotesque and arabesque, added to them for the express purpose of enlarging their air-warming surfaces? Has not all been done that can be done? If more metallic superficies is added, more expense must be incurred, and more space occupied. The stove must be herculean in its proportions, and this alone will for ever forbid an extensive use or sale. The largest amount of heated metallic surface, they say, is already perhaps embraced in the smallest amount of space, and with the greatest possible economy.

It is true, that the fact of the utility of large air-warming surface is, and long has been apparent, and it is equally true, that impressed with this fact, many very good stoves have been invented and put into use. But did they succeed in this behalf to any sensible or reasonable extent? Was success, if any, attained at a reasonable expense? Was the consumption of fuel reduced, or was a great economy in its use introduced? Do not furnaces, both hot-air and hot-water, herculean and otherwise, still consume coals in their voracious jaws, the value of which annually would support perhaps an humble family for an entire year? To the poorer citizen, or even those in middle life, the purchase of a hot-air or a hot-water furnace, with all their faults, bad as they are, is a thing totally out of the question. Such apparatus is expensive to buy, and expensive to keep after being bought. The rich only can afford them. M.

[To be continued.]

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Tower Chronometers, (Continued.)

In our last article, we gave a description of the "remoutoire" escapement, improved from that now in use in London, and which, from its name, we suppose to be taken from the French "remontre," to re-mount or re-wind, which, it will be perceived, it does every half minute; or, in other words, instead of the escapement-wheel being propelled by the clock-weight, as in other clocks, it receives its impetus from the spring wound around its arbor, which spring is in its turn re-wound by the weights every half revolution of the fly, equalizing the impulse given to the pendulum with the greatest accuracy. We also asserted the self-evident fact, that *no clock could keep time whose hands were exposed to the external action of the wind and weather, and at the same time connected directly with the escapement;* and will now, before giving our promised description of the escapement proper, proceed to lay before your readers, for the first time ever published, Mr. Robjohn's invention for remedying this great defect, which, for simplicity and the perfection with which it accomplishes this great object, has never been equalled in clock-work,—possessing, let us also add, the grand qualification of economy as well as perfection. It consists in attaching the weights *directly to the hands, on the same principle as a common windlass, with, if we please, rough cast-iron wheels and pinions, as strong and as heavy as to render it impossible to affect the hands by a gale of wind*, they themselves being made of cast-iron, gilt, or otherwise ornamented to please the eye. It will at once be perceived the economy of this method, which will reduce the expense of a tower chronometer to about that of a well-made regulator, at the same time giving it a degree of perfection *never yet attained*, and reducing that which is now (like the practice of medicine) a matter of experiment, to a *positive certainty*, the only demand made upon the weights in this case being *an atom of their power to wind up a light coil-spring to move the pendulum.*

Having thus overcome the greater obstacles to the time-keeping of tower clocks to our own satisfaction, if not to that of our readers, we will claim their attention a few minutes longer, to describe the last thing necessary to keeping accurate time, and though last, not least important, viz., the escapement proper. And here it again becomes necessary to recapitulate the obstacles in the way of accuracy, in the present system of clocks, before we propose the remedy.

1st. The best astronomical clocks at present made are in connection (that is to say, the pallets and crown-wheel touch each other) *almost all the time*, being only free while the tooth is dropping on the pallet at each vibration, which is but an instant.

2d. Tower clocks are obliged to have a long arc of vibration, to make the pallets clear well the teeth of the crown-wheel, and consequently need heavy weights, which cause such friction as *to wear out even agate pallets* (see old City Hall clock), *and break out the teeth of the crown wheel;* witness Trinity, St. John's, and other clocks during the past month. Astronomical clocks, however, in consequence of their greater delicacy, have lighter weights—in fact, only just heavy enough to give sufficient vibration to clear the teeth from the pallets.

3d. Both receive the impulse of the crown-wheel on the inclined plane of the pallet about 9-10 *of the time of vibration.*

4th. Pendulums cannot be made isochronous, that form a large arc, without some means of shortening that arc towards its termination, consequently the less vibration we get, the more we avoid this defect and lessen the friction.

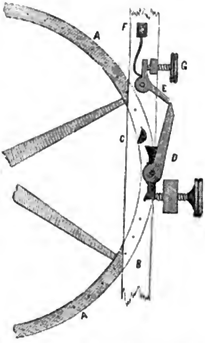
5th. The impulse is given to all pendulums at the *end of their arc*, an improper time, causing a jar by the blow of the tooth, when not needed, as their own gravity would cause them to fall and carry them to the centre, where they should receive an impulse to complete their arc.

Now, if the great advantage that the marine chronometer possesses over the lever and other escapements be the short time of its connection, or, in other words, its perfect detachment being only about 5°, or 1¼ per cent., why, we ask, should not Robjohn's tower chronometer possess the same advantages over tower clocks, as now made, that are really the worst kind of levers, for the lever is disconnected 75 per cent. of its vibration, while the tower clock is not disconnected at all!

The careful study of the following cut will enable the reader to see at a glance how completely Mr. Robjohn's improvements remove the difficulties mentioned, viz.—

1st. His whole time of connection between pallet and tooth is but 1-32 of the vibration.

2d. His arc being shorter, renders it almost free from friction, and his tooth rests on a locking spring, *fixed to the plate of the clock*, as in the chronometer, instead of on the pallet.



3d. He receives his impulse for 1-32 instead of 9-10 of the vibration.

4th. His pendulum is isochronous, from the shortness of its arc.

5th. It receives its impetus in the centre of vibration.

And, lastly, he entirely avoids the friction of the two pivots of the pallet arbor and its weights, *as he has none*, and the friction of the crotch and its attendant rule joints, as in the new City Hall clock, *for he has not them either.*

To understand the following drawing, we must imagine the pendulum B transparent, as the locking apparatus is placed on the far side or back of it, next to the pins in the wheel on which they catch.

A, an escapement-wheel with pins projecting as marked, the same as the common pin escapement wheel, full size, for a 1½ second pendulum.

B, a section of the pendulum (transparent) supposed to be hung in the usual way with spring.

C, a jewel set in the far side of pendulum B, whose inclined surface receives the impulse of the pin in wheel A, on its passage to the right hand, every second vibration, as in the chronometer.

D, the locking pallet and bar, screwed on clock-plate, held to its position by a light quick spring, similar to F. This pallet is jewelled to receive the pin, after having given impulse to C, on pendulum, which it holds until the return beat, when it is unlocked by the trigger.

E, on its passage to the right, and which, after unlocking D, slips past it, and on its return to the left again, slips over the end of locking bar D, assisted by the spring F, and is ready on its return again to the right to unlock D as before.

F, a light spring allowing E to slip over locking bar D.

G and H, two set screws to regulate the depth of locking; one screw on pendulum, the other on clock-plate.

c, c, positions of jewel C, at end of arc of vibration.

In concluding this article, it may be well to add, that these calculations are based upon the supposition that the *pendulum be perfectly compensated and adjusted to heat and cold*, as without this no clock can keep accurate time; for although it may happen that a clock may be exactly right on, say the 1st of May, 1853, and the 1st of May, 1854, yet it may be slow half an hour at the end of the summer, and fast as much at the end of the winter of the same year.

R. G. H.

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Car Axle-Boxes.

[For Appleton's Mechanics' Magazine.]

HAVING noticed a communication in your present June number, page 143, concerning *Car Axle-Boxes*, over the initials of a Mr. D. E. B. of Ithaca, New-York, in which my name figures somewhat personally, to say the least, I deem an answer necessary.

I for one, among a large number of others, have too much respect for your wide-spread and invaluable Magazine, to allow it to put forth impressions which may lead to wrong conclusions, aside from charges unsustainable when fully and honestly investigated by competent persons.

D. E. B. asks, "What constitutes a perfect Car Axle-Box? himself answering, says, "Retention of oil, exclusion of dust, and not being liable to get out of order on account of the component parts becoming lost or broken." He does not say my Box is liable to get out of order, or contains the other defects or bad qualities implied, except its liability to breakage. Here he confounds the axle which broke with the Box which did not break. He says, "The Tims' Box, which was the cause of the late Andover accident, depending upon a groove being turned on the axle, &c. (to which I refer your readers), ought to be abandoned." Does he know I have more than one way of making axles? Does he know the groove plan is cheaper than another I have, and that the Boston and Main R. R. Co. knew of two of my plans, and chose or allowed their car-makers to choose the cheapest plan? Does he know that in your February number, page 48, the machinists who examined the broken axle think the defect must have been plainly in sight for many days! The axle is three inches in diameter; the thickness of an inch and a quarter in the centre was broken at the time of the accident (being 1,227 of the area to 7,068 or 5,703 of the whole area of the three inches), but the remainder, comprising much the greater portion of the iron, has the appearance of having been cracking around, deeper and deeper, for some time, &c. These machinists do not mention the groove at all—why not? they know that axles break where there is no groove, and that it is but supposing the groove was the cause of the breakage.

In your March number, page 69, Mr. Zerah Colburn of Lowell presents a diagram of the broken axle, with a statement of the case, to which I refer your readers.

He says that "without this *sharp-cornered groove*, the axle *might* have been running now,—and they have another in their office (B. & M. R. R. office) similarly broken." He does not, however, say that they have a *pile of broken axles* in their office on *exhibition* without a *groove*. He *might* say they had and now have plenty of them around the works.

It is believed by many practical and scientific mechanics, that a groove may be so proportioned relative to the journal, so as to not be weaker than that part of the journal at its juncture with the shoulder of the axle. This proportion requires the diameter of the bottom of the groove to be larger than the journal, and to be curved or scalloped, not sharp-cornered, as Mr. Colburn says the broken axle was. The larger diameter being to meet the difference in leverage, and with the scalloped bottom to maintain a proper equilibrium of the parts rather more than equal to the strength of the journal. It is wholly optional whether a groove is made in the axle or made in something else. My other plan costs a trifle more in first cost, but removes the objections raised by Mr. Colburn and D. E. B. against the groove being in the axle.

If Mr. Colburn knew I had other plans without his objectional views, he should have told the whole story, by setting forth the plan without the groove in the axle, as well as the one with the groove in the same. By this course the public could choose between the two, and place the blame, if there is any, where it belongs. It is well known to practical railroad men, that axles break at the angle formed by the journal and its shoulder, between the shoulder and face of the hub, and at the face of the hub; also at the back of the hub, between this and the middle as well as at the middle, without a sign of a groove in the same. Again, axles break as above with a groove near the shoulder, while the grooved part remains sound. Undiscovered imperfections may and often do exist in axles got up with the utmost care. In the face of all these facts, who is prepared to swear that the groove was the sole cause of the break? To say it probably was the cause, would be liberal—still of small weight. If axles never broke except in a groove, then a positive statement would be nearer the truth in appearance; even then it might be possible that the iron might be defective at this part. To say the groove was the sole cause is *presumptuous*, and is not borne out by experience and every-day practice. Mr. Colburn says, "If it had not been for the sharp-cornered groove, the axle *might* be running now;" he takes care to qualify his statement with the word *might*, leaving the matter doubtful. Mr. D. E. B. declares it was the cause of the accident;—here is an express declaration, unconditional, and positive. In the face of every-day experience and facts pertaining to axles breaking, what does his declaration amount to? So much for the groove in the axle.

D. E. B. alludes to the possibility of the waste sinking the least possible degree below the bottom of the journal, and, failing to lubricate, certain consequences would follow. There exists no necessity for the want of contact in my Box; his possibility is wholly supposititious, and is not a necessity or liability with common care. His possibility applies to all things made by man.

The other evils he refers to, are inapplicable to my box. I therefore pass them by. The blunder made by the English in not writing to me when my plan of box was presented to them (in answer to their written inquiry) as to the best box in this country, over which D. E. B. laments, as affecting the honor of our country, I deem of small consequence. If he, or any one else has humbugged them by a half-told story, based upon ignorance or a desire to create a false impression, the Tims' plan of box is not answerable for it. Let them write to me in the right way, and I will guarantee they will not get humbugged in car axle-boxes, as well as a number of other valuable improvements D. E. B. has not even dreamed of, and of course not yet condemned. He is the first to inform me that my plan of box has been presented to the English as the best in this country. My plan of car axle-box contains all the requirements mentioned by D. E. B. at the head of his communication, as well as some other good things he has not mentioned. This I can prove. I invite a rigid investigation of my statements already made, as well as what now follows, by an impartial and fully competent commission.

The following is what I guarantee:—*First*, that my plan of car axle-boxes is capable of running 4000 miles with one supply of oil, and I am ready to prove they have run 8000 miles with one supply of oil, under experiment by a company, when trying them previous to their buying the right. I am also ready to swear that the composition of copper and tin pillows or bearings, would wear ten years' running time of 200 miles per day, at the rate they move in running 88,400 miles at the trial above alluded to.—*Second*, that the same space shall be run with less oil (if my directions are complied with) than any other box in any country that uses oil to lubricate the rubbing parts. *Third*, the parts and oil shall be kept cleaner throughout, both outside and in, than any other box that is closed up in as cheap a manner. *Fourth*, the axle shall be as strong, if not stronger, than any other axle of like size and weight, constructed of one solid bar, having both wheels rigidly attached to the same, and revolving exactly together at all times.

Fifth, I am ready to undergo as rigid an examination as any of Adam's children are able to put forth, as to the *science* and *philosophy* of the desiderata required in car axle-boxes, as well as how to accomplish them; and, if I fail, I will own up honorably, and he who excels me honorably.

shall have a good friend in me to recommend him. To sink my fellow that I may swim, is no part of my creed.

The personalities of D. E. B. and responsibility of your Magazine, must be my apology for trespassing on your columns and the public's patience. To reason logically and soundly, or to knock down by false impressions, are very different things. I am astir yet. JOHN H. TIMS,

202 Washington St., Newark, N. J.

June 27th, 1853.

Monthly Notes.

The great event of the month has been the formal opening, but not the completion of the Crystal Palace. The main building was by great exertions completed on the 13th; the staging removed and the platform erected under the dome, in time for the ceremonies on the 14th, as advertised. The ceremonies were, prayer by Bishop Wainwright of the Episcopal Church, addresses by the president of the association and by the President of the United States, and chorus-singing. The exhibition was opened to the public on the 15th, and every additional day has added to the display. With all its drawbacks and delays, it promises to be an honor rather than a disgrace to our city and our country. We have so long accorded it a rather reluctant encouragement: have endured it as a necessity forced upon us, rather than a spontaneous movement by the American people. But this feeling has given way to admiration of the building, its contents, and the enterprise rather, than capacity of its originators. The machine-arcade and picture-gallery in the rear will probably be completed by our next issue.

The supposed new metal, Thalium, the discovery of which by Dr. Owens was briefly noticed on page 24 of our present volume, has been examined with great care by Prof. J. Lawrence Smith, and pronounced to be simply a compound of magnesia and lime.

Glycerine, one of the useless products of the soap and candle manufacture, has been lately recommended as an ingredient for moulding sand, to prevent its drying. A concentrated solution of glycerine is kneaded with the sand, and it is found to retain its moisture and consistence as required.

A party of western lumbermen had intended to send an immense log to the Crystal Palace, but were deterred by a report that the eastern Yankees had a method of melting wood, and casting it into any size required. This has gone the rounds as a tolerable squib for some weeks; but it appears to have been true, except in the location of the invention. The June number of "Newton's Repertory" gives the specifications of an English patent for manufacturing "boards or sheets of great strength and lightness, for many purposes for which wood is now required." The material appears to be almost any vegetable fibre. The straw, hop-vine, or other material is cut up, boiled in a solution of hydrate of soda or potash of from 7° to 10° Beaumé, washed, and beat to a pulp. This pulp is then moulded and pressed, oiled, and baked. Any coloring matter may be added during its manufacture.

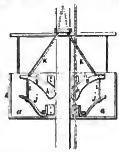
Machinery for the manufacture of steel pens has lately been shipped from Birmingham to this country. Our English contemporary is quite mistaken in supposing this to be the first attempt to manufacture metallic pens in America.

An apparatus for steering by steam has been patented in England; the steam being admitted or exhausted on either side of a piston connected to the rudder. This would be a very efficient method of putting the helm "hard" to either side immediately, but would not be desirable for ordinary steering, as it would seem to involve a considerable expenditure of steam for the slight movements continually necessary. We would suggest its application to our East River ferry-boats. The elasticity of this method of holding the rudder might be rather an advantage in heavy seas.

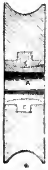
The latest application of caoutchouc is to the scales of thermometers. Owing to the impossibility of making the bulbs and tubes of a lot of thermometers precisely alike, a separate scale has to be marked for each—a serious expense when applied to the cheaper class of these useful instruments. By using the Indian rubber as a material, a large lot of scales may be printed from one plate, all a little too short, and each of which is stretched to suit the particular tube to which it may be fitted. If the scale is homogeneous and of equal thickness throughout, adjustment must necessarily be perfect.

A capital idea in connection with the use of the fan-blower is detailed in the "Glasgow Mechanics' Journal." It is simply the use of two fans working the air from one into the other, both fans being on one shaft, if desired. We see no limit to this method of increasing the pressure of the blast, as any number of fans may be employed, and the scheme appears to obviate completely the difficulty heretofore attending the attainment of a tolerable pressure. The inventor states, that using the same size and velocity, the second fan *nearly* doubles the pressure of the blast.

Mr. Slade, the inventor of the engine known in Cornwall as the "man-engine," for raising and lowering men with safety in the shafts of mines, has recently patented in England a safety-hoist, for the transfer of men and building materials between the various stages in the construction of large edifices. The apparatus consists substantially of two buckets or vehicles suspended to a drum or fixed pulley, so that one descends as the other rises. The power may be a steam-engine applied to the drum at the top, when used as a permanent hoist in a factory, or by the weight of the laborer in the opposite tub when applied to the construction of buildings. Used in this latter manner, Mr. Slade estimates that the brick and mortar elevated would exceed that by the same amount of labor, according to the ordinary method, in the proportion, of about 8 to 1. So far there is no novelty.



The safety attachment is as follows: A is the bucket, supported by the ropes or chains *k k*, which are attached to the longer arms of the levers *g g*. These levers are free to turn within certain limits on the fulcrums *h h*. In case of fracture of the chains, the longer arms are drawn down by the springs *j j*, causing a pressure of the shorter arms against the guides, and effectually preventing any serious accident arising from its too rapid descent.



Among the foreign inventions, we find the following method of attaching the bush to the sheave of ships' blocks, which may be conveniently adopted, as, in fact, very similar arrangements often are applied to other purposes. Instead of rivets passing through the bush into the wood, make the bush rough and square, or octagonal, and fill the space between it and the wood with lead or tin. An annular groove may be cut in the sheave, and a similar one sunk in the bush, to prevent motion laterally, or the whole exterior of the bush may be recessed in the centre, as in the accompanying cut.

It makes a more solid and neat job, and avoids all danger of splitting the wood, while it is cheaper than the old method.

A notice recently issued by the Commissioner of Patents, announces that "hereafter no caveat be placed in the secret archives of this office unless accompanied by an oath of citizenship and originality of invention."

Steel, which has been overheated or burned, is recovered by repeated heatings and hammerings; some workmen preferring to harden it after each hammering in cold water. Late experiments at the Royal Mint and elsewhere in Berlin, have been successful in recovering such steel, by heating to redness and cooling in boiling water.

Machine-shops every where appear filled with orders; in fact business is too good to make an exhibition of work in the Crystal Palace, as much an object as at ordinary times for American mechanics. Among the large jobs now contracting in this city, the Novelty Works have in hand one side-lever engine, 85 inches diameter of cylinder and 8 feet stroke (for a steamer to run between this port and Charleston); one 85 inch diameter 8 feet stroke, single oscillating engine (similar to the "Augusta," and to run with her between New-York and Savannah); one 88 inch, 11 feet, beam engine (Savannah and ———); one 36 inch, 8 feet inclined engine (Albany ferry-boat); a number of stationaries, one of which is 36 inch, 5 feet stroke, and a host of quartz-crushers, brick-machines, &c.

The Morgan Works, near by, are building no less than 19 large low-pressure steam-engines, and give direct employment to about 718 hands. Two of these are 42 inches diameter and 10 feet stroke for the steamer Jamestown; 6 are 50 inch beam-engines for vessels being constructed for Messrs. Howland & Aspinwall; 2 65 inch, by 10 feet, oscillating, for the steamer "San Francisco;" 2 65 inch, 10 feet stroke, for the U. S. M. steamer "George Law;" 1 60 inch, 12 feet stroke, for the "Lake Erie;" 1 83 inch, 12 feet, for the "Golden Age" (Howard & Son, Australia line); 1 30 inch cylinder, 6 feet stroke (an additional engine for the "San Francisco"); 2 60 inch, 11 feet cylinders for the "Vera Cruz;" 1 44 inch, 9 feet, for the Chicago Water Works; and 1 44 inch, 11 feet, for some place on the river Danube, in Europe.

Fig. 1. Working Parts detached. Scale 1 in. = 1 Ft.

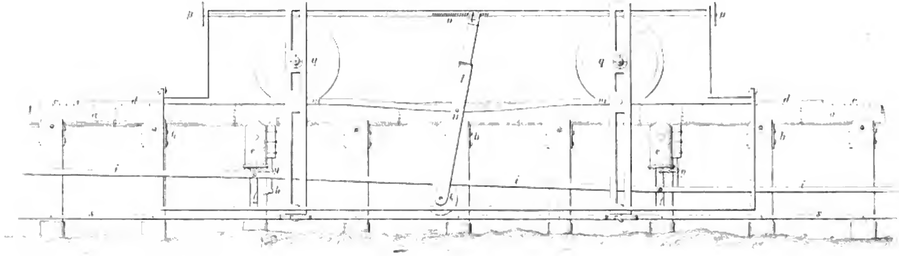
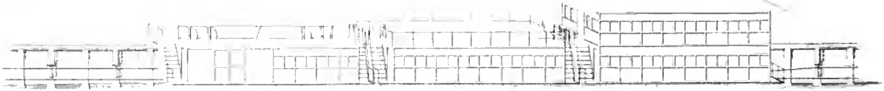


Fig. 2. Projection. Scale 1 in. = 20 Ft.



LEE'S RAILWAY.

Inv.d & Drawn by Edward E. Lee C.E.

Engraved for Appleton's Mechanics' Magazine by W.S. Barnard N.Y.

APPLETONS'
Mechanics' Magazine and Engineers' Journal.

No. 9.—Vol. III.—SEPTEMBER 1st, 1853.

LEE'S PIPE RAILWAY.

Communicated by the Inventor, Edmund F. Lee, Civ. Eng., Louisville, Ky.

Referring to the engravings, *a* is a pipe, which is supported on pillars above the ground.

At proper intervals, slip-joints are provided to allow for the expansion and contraction of the material. These are packed with rubber, confined by a lap-band, which may be tightened with screws. The ends of the pipe, at these joints, are prevented from separating, except within certain limits, by the same bars and bolts *b*, by which the pipe is secured to the pillars.

The pipe may be made of cast-iron, but will be better made principally, if not entirely, of boiler plate, riveted together, so as to form a projecting flange *c*.

This flange is covered by a bridge or saddle-rail *d*.

Along the under side of the pipe, a series of common working cylinders *e*, are attached in an inverted position, and communicate with the pipe through the valve-chest.

Besides the usual apparatus, *f* are two rods, having an off-set or shoulder near each end, at the proper distance apart.

These pass through slots in the cross-head, and are connected at the top by the rock-lever *g*, with the slide-valve stem.

h is a simple cut-off, which is worked by the cross-head.

In the valve-chest there is also a puppet-valve, by which the communication with the pipe may be closed, whenever the valve-chest is open.

On each side of the railway, the cross-heads are connected by the propelling bars *i*. They are framed together laterally, in pairs, and are made to slip a little at the joints, equal to the greater distance between the cross-heads, when their position is diagonal.

k are the driving-wheels. They are provided with double flanges, and turn on axles which are supported by the fork *l*, the prongs of which are connected to elastic spring-pieces *m*, of the running frame, by the joints *n*.

This fork is vibrated to a certain extent by the screw *o*, working in a movable nut, by turning the hand-wheel *p*, at either end of the frame; by which means the driving-wheels are adjusted to the propelling bars, and made to open the valves, or liberated therefrom, as may be necessary.

q are the travelling-wheels of the cars.

The usual form of the cars will be that of two compartments, suspended one on each side of the railway; but in some cases a third may be added above the railway. At the bottom, they are provided with friction-wheels *r*, which travel against light side-rails *s*, to prevent lateral oscillation.

The mode of operation is as follows: The pipe being supplied with compressed air, by means of stationary engines, the inner flanges of the driving-wheels in passing a cylinder roll over the shoulders on the rods *f*, and open the valve, which, admitting the air, the pressure is transmitted through the piston and propelling bars to the driving-wheels, and these, yielding a little to the pressure, allow the propelling bars to present an inclined surface, along which they are impelled by the oblique pressure of these bars, aided by the reaction of the spring to which they are attached.

In this way, the pistons acting successively, the cars are moved from cylinder to cylinder, either by the upward or downward strokes of the piston, in either direction, and either singly or in trains, each alternate pair of driving-wheels working above or below the propelling bars.

The railway may be operated with equal facility by atmospheric pressure, brought into action by means of a vacuum created within the pipe, as in the case of the well-known atmospheric railway, except that the vacuum may be constant. Some slight modification of the machinery, however, would be required, as the motions of the slide-valve would be reversed, and it would be necessary, also, to press the valve against the face with a spring.

The operation of turning out may be effected either by means of a simple turn-table, a gate movement of a portion of the track, or by a direct transverse movement, the special arrangements of which will be sufficiently obvious. The turn-outs may be operated by the same power as the railway, as well as other machinery at the stations and landings, such as elevators for transferring freight, &c.

At each turn-out the pipe is carried across under the surface of the ground, and at these points it will be most convenient to connect the two lines of a double track, and to insert such valves as may be necessary to open or close the communications between consecutive, diagonal, or opposite sections.

Whenever the cars are stopped by the brakes, if the driving-wheels are not disengaged from the propelling bars, they will start again as soon as the brakes are released, otherwise they must be started by hand, or by opening the proper valve.

On curves, the driving-wheels will admit of a small lateral motion, equal to the versed sine of half the arc between the points of contact of the travelling-wheels with the rail.

They are not necessarily, however, placed at the middle of the car. The fork by which they are supported may be attached to springs between two travelling-wheels, near one end, or elsewhere, as may be most convenient.

On grades, the power may be varied according to the degree of inclination, by increasing or diminishing the diameter of the working cylinders, or their distance apart, or by working the air more or less expansively.

The application of the power to the propulsion of the cars will produce a nearly uniform motion, the angle of action and leverage of the propelling bars increasing as the pressure on the piston diminishes; and the loss of power from friction will compare favorably with that which is due to the crank movement and ordinary conditions of the machinery of locomotives.

The advantages claimed for the pipe railway are, superior economy, safety, speed, convenience, and general applicability to the purposes of transportation.

The permanent way, constructed in a durable and efficient manner, will cost no more than the average of common railways, or from $25,000 to $35,000 per mile.

The Baltimore and Ohio Railroad, without equipment, cost $33,000, and the New-York and Erie road, $43,000 per mile.

The railways of Massachusetts cost $46,000 per mile, including equipment. These may be considered fair specimens of good roads, but they are still in general incomplete, and will require further expenditures chargeable to cost.

The average annual expenses of the railways of Massachusetts, for 1852, was about $3,200 per mile of road and branches, of which $650 was due to road-bed, $520 to motive power, and $2,030 miscellaneous.

For the pipe railway, when permanently constructed, the item of depreciation and renewal will be inconsiderable; and, as there will be no heavy embankments to settle or wash away, no deep cuts to be cleaned out, no double line of rail to be frequently adjusted, and no cross-ties or ballasting to be replaced, &c.; the expense for repairs will also be unimportant, except of the propelling machinery, which will correspond to that of ordinary railways, and will probably cost no more to keep it in order.

In consequence of the cheaper power of stationary engines, the primary motive power will cost less, and in some cases, where water power can be made available, incomparably less than for the common railway.

As there will be less rolling machinery, fewer sources of danger, and much greater simplicity in the construction and operation of the entire machine, the miscellaneous expenses of management, attendance, cars, stations, &c., will of course be less.

According to the report of operations of the railways of Massachusetts, for 1852,

The gross work in tons carried one mile, including passengers, at 14 to the ton, was, ...	322,000,000=100	per cent.
Useful effect—passengers, freight, and gravel, ...	89,000,000=28	"
Dead weight carried one mile, . .	258,000,000=72	"

From which it appears that nearly three tons of dead weight was carried for one ton of useful paying load.

It may be estimated, that about 100,000,000 tons of this dead weight was that of the locomotive and tender, which would not have been transported on the pipe railway, and which cost, at one cent per ton per mile, $1,000,000.

It will be seen, therefore, that less power will be needed for the pipe railway; that its *useful* effect will more clearly approximate its *gross* capacity; and that by avoiding this enormous waste, the profits on the same amount of business will be greatly increased.

The total constant power required to do the average work of all the railways of Massachusetts, comprising 1,150 miles of road, at 20 lbs. of traction per ton, is less than 2,300 horse-power, or two horse-power per mile.

The efficient power always at command is more than ten times this amount, and at least an equal amount is probably lost in blowing off, running after wood and water, transferring engines, &c.

An equal power is generated by a stream of water 100 feet wide and five feet deep, having a current of three feet per second, and falling fifteen feet.

With the pipe railway such stationary power may be appropriated; and after allowing for a corresponding loss of power from leakage or otherwise, it is evident that there will be cases, in which not only a sufficiency, but a large surplus of cheap power may be furnished, at water-falls, coal mines, &c.

Under favorable circumstances, a valuable revenue may be derived from the distribution of this surplus, through the pipe to the working-engines of manufactories along the line.

This power would be more convenient than any other, and in some cases would yield a profit equal to the interest on the total cost of the railway and equipment.

In regard to safety and speed, the first requisite is a good substantial road, kept in perfect adjustment, and free from all obstructions; but in the case of the common railway, this is found to be utterly unattainable in practice; and it is unfortunate, also, that the most prolific sources of danger, heavy engines, long trains, and high rates of speed, are, at the same time, the essential sources of profit.

Heavy engines must be used, in order to ascend the maximum grades with facility; and the greater the surplus of power which can be commanded, the greater will be the useful effect, not only directly, but indirectly, by using the power more economically.

But the greater power can only be used to advantage with long trains, because a sufficient load cannot be crowded into a few narrow cars.

It is necessary, also, that the passenger-trains be run as rapidly as possible, in order to secure the greatest amount of business; and the freight-trains must be run so as to clear the way for the passenger-trains.

The conditions of safety and profit are, therefore, directly antagonistic, and the most powerful considerations are constantly presented to induce unwarrantable risks.

The tremendous momentum of ordinary trains, ranging from 20,000 to 60,000 tons, cannot be reduced by the small checking power at command, except within certain limits of time and distance; and any sudden stoppage, whether produced by an obstruction, collision, or running off the track, is necessarily equivalent to a serious accident.

On the pipe railway, with a track which is neither affected by frost, snow, or rain, and is always in adjustment, and free from obstructions, and with light cars, which can neither overturn nor run off the track, a high rate of speed may be attained with comparative safety.

All the crossings will be above the common roads, so that there can be no collisions, except of meeting or overtaking trains, and this, as well as every other appreciable source of danger, will, in general, be avoided, by the power of checking up within a very short distance.

There will be no inducement for persons to walk near the track, and if run over, they will not be crushed by the wheels. There will be no danger from drawbridges, nor from fire, nor from the explosion of boilers, nor from the failure of axles, wheels, or other machinery of the cars or railway; and if the pipe itself should be broken, this would only prevent the cars from approaching the place of the accident.

The advantages of this railway, in point of comfort and convenience in the transportation of passengers and merchandise, are especially conspicuous.

The cars will admit of greater variety of form and arrangement than ordinary, in adapting them to special business, and their motion will be easier and more uniform, without being interrupted by twisting and sudden jerks.

There will be no dust, smoke, or sparks to annoy passengers; and they will also be free from the oppressive apprehension of danger, which is now so common.

For merchandise, the cars may be so arranged as to facilitate the transfer of loads to and from the railway, by means of elevators, without displacement of goods, and the goods will also be better preserved in transitu, in consequence of the easier motion of the cars.

Other advantages of this railway are, that it may be conducted through the streets of cities without interfering with their ordinary use; across rivers, without interrupting the navigation, and over mountains, without tunnelling.

Its operation does not depend at all upon the bite, or friction on the rail, and by concentrating the power according to the requirements of the grade, any *necessary* degree of inclination may be overcome, maintaining at the same time a uniform velocity of the cars.

For this reason, also, the necessity of sharp curvatures, on account of grades, will, in general, be obviated; and the railway may, therefore, be located on a very direct course between the termini.

Hilly routes, which admit of easy changes of direction vertically, will, indeed, rather be sought than otherwise, for the sake of water-power; and, in general, this railway will have an almost unlimited range of applicability, besides combining in an eminent degree the advantages of the common railway, with the capacity, and, in some cases, the cheapness of water transportation.

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Wave-line Ships and Yachts.

Mr. Scott Russell, during the past year, read to the Royal Institution the following paper on this subject, suggested by the assertion which, within a year or two, has been so often repeated—that the Americans are building better ships than the English. He says:

"Two questions of a practical nature arise out of this alarming assertion: 1st. Whether the Americans are really in any respect superior to the English in nautical matters? 2d. Whether in order to equal them we are to be condemned to descend into mere imitators, or whether we have independent ground from which we can start with certainty and originality on a new career of naval architecture? In the outset I beg permission to say, that I am not one of those who shut their ears to the praises of our young and enterprising brethren over the water, or view their rapid advancement with jealousy. I beg to express my perfect belief in the accounts we have heard of their wonderful achievements in rapid river steam navigation. I am satisfied, as a matter of fact, that twenty-one, twenty-two, and twenty-three miles an hour have been performed, not once but often, by their river steamboats. To that we cannot, in this country, offer any parallel. The next point in which they had beaten us was, in the construction of the beautiful packet-ships which carried on the passenger trade between Liverpool and America before the era of ocean steamers. These were the finest ships in the world, and they were mainly owned and sailed by Americans. The next point at which we have come into competition with the Americans has been lately in ocean steam navigation.—Three years ago they began. They were immeasurably behind us at starting—they are already nearly equal to us. Their transatlantic steam-packets equal ours in size, power and speed; in regularity they are still inferior. If they continue to advance at their present rate of improvement, they will very soon outstrip us. Next I come to the trade which has long been peculiarly our own—the China trade. The clipper ships which they have recently sent home to this country have astonished the fine ships of our own Smiths and Greens. Our best ship-owners are now trembling for their trade and reputation. Finally, it is true that the Americans have sent over to England a yacht, called the America, which has found on this side of the Atlantic no match; and we only escaped the disgrace of her having returned to America without any of us having had the courage to accept her defiance through the chivalry of one gentleman, who accepted the challenge with a yacht of half the size, on this principle, so worthy of John Bull, "that the Yankee, although he might say that he had beaten us, should not be able to say that we had all run away." Such then at present is our actual position in the matter of ships, yachts, and steam navigation—a position highly creditable to the Americans, and which deserves our own very serious consideration. I propose to examine a little into the physical causes of the naval success of the Americans; but before doing so, permit me to point out a moral one, which later in the evening you will also find to lie at the bottom of the physical causes. It is this—John Bull has a prejudice against novelty—Brother Jonathan has a prejudice equally strong in favor of it. We adhere to tradition in trade, manners, customs, professions, humors—Jonathan despises it. I don't say he is right and we are wrong; but this difference becomes very important when a race of competition is to be run.

"These preliminary remarks find immediate application in the causes which have led to our loss of character on the sea. The Americans, constantly on the alert, have carried out and applied every new discovery to the advancement of navigation; while with the English, naval construction and seamanship is exactly that branch of practice in which science has not only been disregarded, but is altogether despised and set aside. The American ships show what can be done by modern science unflinchingly put in practice; the English show what can be done in spite of science, and in defiance of its principles. The immediate cause of the defects of English ships, and the most glaring instance of the outrage of all true principle in the practice of navigation, was to be found for many years in the English tonnage law. It was simply an act of parliament for the effectual and compulsory construction of bad ships. Under that law, the present fleet of merchant ships and race of ship-builders have chiefly grown up; and though at length and only recently abrogated, its influence is still left behind and is widely prevalent. This act of parliament compelled the construction of bad ships under heavy penalties. The old tonnage law, according to which ships were built and registered, and taxed, and bought and sold, virtually said to the builder and owner—'Thou shalt not build a ship of the necessary beam to carry sail; thou shalt not give her the depth and height necessary to security and seaworthiness; thou shalt not build her of any suitable shape for speed, under penalty of 20, 30 and 40 per cent. of fine for every ton of freight so carried in such ship.' In short, the law offered a premium on a ship the amount of which was in the proportion of her being wall-sided, top-heavy, crank, unweatherly and slow; while it inflicted a penalty in the shape of port charges, pilot and harbor dues, lights, &c., in proportion to her fitness and reputation as a seaworthy, fast and wholesome ship. To cheat the law—that is, to build a tolerable ship in spite of it—was the highest achievement left to an English builder, and formed his continual occupation. The manner in which the English system was opposed to the good qualities of a ship, especially speed, is only to be understood by an analysis of these qualities.

"The two examples selected for illustration of the qualities of sailing vessels were the yacht America, built without restriction of any kind, and the yacht Titania, built under the restrictions of the law of measurement of tonnage, which is still retained in all its deformity by the English yacht squadron. It was shown how the element of 'stand-up-ativeness' is dependent on the beam of the vessel at the water-line; how the power of carrying sail depends on this element; and how this element is prohibited to the utmost by the yacht club's law of tonnage. Another element of the vessel, the area of her vertical longitudinal section immersed in the water, is, by another portion of the law, compelled to be reduced in an injurious degree. It was next shown that in the other elements of the form of the two vessels they were nearly identical; and that they were both under water constructed on the wave principle in its most perfect form. But for the existence, therefore, of these antiquated laws, our yacht-builders and our ship-builders would have had nothing to fear from competition. Happily, the mercantile tonnage law had been altered, and the new law was all that could be desired; and in consequence a new race of fast ships was rapidly springing up. The old yacht law unhappily remained. It appeared, from the comparison which was instituted between the construction of American and English vessels, that the American ship-builders have gained over the English chiefly by the ready abandonment of old systems of routine, and the adoption of the true principles of science and the most modern discoveries. They have changed their fashions of steamers and ships to meet new circumstances as they arose. For river steamers they at once abandoned all the known sea-going forms, and created an absolutely new form and general arrangement both of ship and machinery. We, on the other hand, subject to the prejudices of a class, invariably attempted to make a river-steamer as nearly as possible to resemble a sea-going ship propelled by sails. We were even for a long time so much ashamed of our paddle-wheels that we adopted all sorts of inconvenient forms and inapt artifices to conceal them, as if it were a high achievement to make a steam vessel be mistaken for a sailing vessel. The fine sharp bows which the wave principle has brought to our knowledge have been adopted in this country with the greatest reluctance, and those who adopt them are often unwilling to allow that they are wave-bows, and would fain assert that 'they always built them so,' were it not that ships' lines are able to speak for themselves. The Americans, however, adopted the wave-bow without reluctance, and avowed it with pleasure the moment they found it give them economy and speed. In like manner, the Americans having found the wave-bow or hollow bow good for steamers, were quite ready to believe that it might be equally good for sailing vessels. We, on the other hand, have kept on asserting that though we could not deny its efficacy for steamers, it would never do for vessels that were meant to carry sail. The Americans, on the contrary, immediately tried it on their pilot-boats, and finding it succeed there, avowed at once, in their latest treatise on naval architecture, the complete success of the principle, not even disclaiming its British origin. To prove to ourselves our insensibility to its advantages—they built the America, carried out the wave principle to the utmost, and despising the prejudices and antiquated regulations of our clubs, came over and beat us. The diagrams and models which were exhibited, showed the water-lines of the America to coincide precisely with the theoretical wave-line. In one other point the Americans had shown their implicit faith in science and their disregard of prejudice. Theory says, and has always said, 'sails should set flat as boards.' We have said, 'they should be cut so as to hang in graceful waves. It has always been so; we have always done it.' The Americans believed in principle, and with flat sails went one point nearer to the wind, leaving prejudice and picturesque sails far to leeward. In other points the Americans beat us by the use of science. They use all the refinements of science in their rigging and tackle; they, it is true, have to employ better educated and more intelligent men—they do so; and by employing a smaller number of hands, beat us in efficiency as well as in economy."

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Specific Heats of Elastic Fluids.

BY M. V. REGNAULT.

I have been employed for more than twelve years in collecting the elements necessary for the solution of the following general problem:

"A certain quantity of heat being given, what is, theoretically, the moving force which can be obtained from it by applying it to the development and dilatation of different elastic fluids, in the various circumstances which can be realized in practice?"

The complete solution of this problem would give the true theory, not only of the steam engines now in use, but also that of engines in which the vapor of water was replaced by other vapors, or even by a permanent elastic fluid, whose elastic force should be augmented by the heat.

At the time I began these researches, the question appeared to me more simple than it does at present. Starting from ideas then admitted in science, it was easy to define clearly the different elements which compose it, and I imagined processes by aid of which I hoped to succeed in finding in succession their laws, and fixing their numerical data. But, as usually happens in the sciences of observation, as I proceeded in my studies, the circle continually augmented; the questions which at first seemed to me the most simple, became quite complicated, and perhaps I should not have had the courage to attack the subject, if at the beginning I had understood all the difficulties.

It has been admitted, until lately, that the quantities of heat disengaged or absorbed by the same elastic fluid were equal, when the fluid passed from the same initial to an identical final state in whichever direction the transition took place; in a word, it was admitted that the quantities of heat depended only on the initial and final conditions of temperature and pressure, and were independent of the intermediate circumstances through which the fluid passed. S. Carnot published in 1834, under the title of "Reflections on the Motive Power of Fire," a work which did not at first excite much attention, and in which he admits as a principle, that the motive force produced in a fire-engine is due to the passage of the heat from the more heated calorific source which emits the heat to the cooler condenser which finally collects it.

M. Clapeyron has developed mathematically the hypothesis of Carnot, and he has shown that the quantities of heat gained or lost by the same gas, then do not depend solely upon its initial and final state, but also upon the intermediate state through which it is made to pass.

The mechanical theory of heat has regained favor within a few years, and it now employs a great number of mathematicians. But the principle of Carnot has undergone an important modification; it has been admitted that heat may be transformed into mechanical work, and that reciprocally mechanical work may be transformed into heat. In the theory of Carnot, the quantity of heat possessed by the elastic fluid at its entrance into the engine is found entirely in the elastic fluid which issues from it, or in the condenser; the work is done merely by the passage of the heat from the boiler into the condenser, while it traverses the engine. In the new theory, this quantity of heat is not entirely preserved in the form of heat; a portion disappears during its passage through the machine, and the work done is in every case proportional to the quantity of heat lost. Thus, in a steam engine with or without condensation, with or without cut-off, the work done by the machine is proportional to the difference between the quantity of heat which the vapor has at its entrance into the machine, and that which it keeps at the moment of its exit or condensation. In this theory, to obtain the maximum mechanical effect from a given quantity of heat, we must make this loss of heat the greatest possible; that is to say, the elastic force which the expanded steam keeps at the moment of its entrance into the condenser, must be as small as possible. But in every case, in the steam engine, the quantity of heat utilized in mechanical work will be but a very small portion of that which we have been obliged to give to the boiler.

In a steam engine in which the steam is expanded, but not condensed, the steam entering under a pressure of 5 atmospheres, and discharged at atmospheric pressure, the quantity of heat which the steam has, when it enters the machine, is, according to my experiments, about 653 units; that which it retains at its discharge, 637.* According to the theory of which I am speaking, the quantity of heat utilized in mechanical work is $653 - 637 = 16$ units; that is, only $\frac{1}{41}$th of the quantity of heat given to the boiler. In a condensing engine, receiving its steam at 5 atmospheres, and the condenser keeping constantly, an elastic force of 55 min. of mercury, the quantity of heat in the entering steam will be 653 units, and that which it has, at the moment of its condensation, 619. The heat utilized will be 34 units, or a little more than $\frac{1}{20}$th of the heat given to the boiler.

A larger portion of the heat may be utilized in mechanical work, either by overheating the steam before its entrance into the machine, or by lowering as much as possible the temperature of the condenser. But this latter means is hard to realize in practice; it would moreover require a considerable increase in the quantity of cold water necessary for effecting the condensation, which wastes power, and the boiler can only be fed by water which is but little heated. We shall attain the same end more easily by expanding the steam to a less degree in the machine, and condensing the steam by the injection of a very volatile liquid, such as chloroform or ether. The heat which the steam has at the moment of this condensation, and of which but a very small part would have been transformed into mechanical work, passes into the more volatile liquid, which it transforms into vapor of high pressure. By passing this vapor into a second machine, where it expands to the elastic force to which the injection water can practically reduce the condenser, a part of the heat is transformed into mechanical work, and a calculation founded on the numerical data of my experiments, shows that this quantity is much greater than could have been obtained by the further expansion of steam in the first machine. In this way can be perfectly explained the economical result obtained from two connected machines, the one working with water, the other with ether or chloroform, on which experiments have been recently made.

In the air engines, where the motive force is produced by the dilatation which heat produces upon the gas in the machine, or by the increase which it produces in its elastic force, the work done at each stroke of the piston will always be proportional to the differences of the quantities of heat in the air entering and leaving, that is, to the loss of heat by the air in traversing the machine. But as, in the Ericsson system, the heat which the air gives out is given up to bodies from which the entering air takes it again, and brings it back to the machine, we see that, theoretically, all the heat expend-

* Our author here uses the French unit of heat, which is equivalent to heating 1 gramme of water 1 degree centigrade. The quantity of steam is evidently assumed at 1 gramme. To reduce M. Regnault's result to convenient English measures, we may say:—The total amount of heat required to convert 1 lb. of water at 32° Fahr. into steam at atmospheric pressure, is 1175·4 English units, equal the amount required to heat 1175·4 lbs. of cold water 1 degree Fahr. This is a higher result than that found by Dr. Black [=1150], or Dr. Ure]=1147], but not as high as that of W. R. Johnson in his experiments on coals [=1210].—[Ed. Am. Mech. Mag.

ed is utilized for mechanical work; whilst in the best steam engine the heat utilized in mechanical work is not the $\frac{1}{20}$th part of the heat expended. Be it observed here, that I neglect all the extraneous sources of loss, as well as the mechanical or practical obstacles which may present themselves in the application of the principle.

MM. Joule, Thomson and Rankine, in England, and MM. Mayer and Clausius, in Germany, starting frequently from different points of view, have developed analytically this mechanical theory of heat, and have sought to deduce from it the laws of all the phenomena relative to elastic fluids. For my own part, I have for a long time expressed in my courses of lectures, analogous ideas, to which I had been led by my experimental labors upon elastic fluids. In these researches I in fact met anomalies which appeared to me inexplicable in the theories before admitted. To give an idea of them I will cite some of the most simple examples.

First Example.—1st. A mass of gas under a pressure of ten atmospheres, enclosed in a space the capacity of which is suddenly doubled; the pressure descends to five atmospheres.

2d. Two reservoirs of equal capacity are placed in the same calorimeter; the one is filled with a gas under 10 atmospheres, the second has a complete vacuum. The communication between the two reservoirs is suddenly opened; the gas expands into double its volume, and the pressure is also reduced to 5 atmospheres.

Thus in the two experiments the initial and final conditions of the gas are the same; but, this identity of conditions is accompanied by very different calorific results; for, whilst in the first case a considerable cooling is observed, in the second the calorimeter shows not the least change of temperature.

Second Example.—1st. A mass of gas traverses, under atmospheric pressure, a worm in which it is heated to 100° Cent.; then, a calorimeter whose initial temperature is 0°. It raises the temperature of the calorimeter t°.

2d. The same mass of gas traverses, under the pressure of ten atmospheres, the worm, in which it is heated to 100°, then the calorimeter at 0° under the same pressure; it raises the temperature of the calorimeter t'°, and experiment shows that t and t' are but slightly different.

3d. The same mass of gas under the pressure of 10 atmospheres, traverses the worm, in which it is heated to 100°; but, when it arrives at the orifice of the calorimeter at 0°, or to any point of its course, the gas dilates, and descends to the pressure of the atmosphere; so that it issues from the calorimeter in equilibrium of temperature with it, and in equilibrium of pressure with the surrounding atmosphere. An elevation of temperature t'' is observed in the calorimeter.

According to the theories formerly admitted, the quantity of heat abandoned by the gas in experiment No. 3, ought to be equal to that of No. 2, diminished by the quantity of heat which has been absorbed by the gas during the enormous dilatation which it has undergone. On the contrary, experiment shows a higher value for t'' than for t' and t. I might multiply these citations, but I should anticipate what I have hereafter to say. I reserve the farther elucidation until I shall publish together the experiments which I have made on the compression and dilatation of gases.

However, the examples which I have just cited suffice to show how careful we must be in the conclusions to be drawn from the experiments in which elastic fluids are in motion, undergo changes of elasticity, and perform mechanical work often difficult to appreciate; for the calorific effects produced depend in great part upon the order and manner in which these changes have taken place.

Unhappily, if it is easy to announce vaguely a physical theory, it is very difficult to specify it with precision, so as not only to connect with it all the facts known to science, but also, to deduce from it those which have heretofore escaped observation. The theory of luminous undulations, as it was established heretofore by Fresnel, presents the only example heretofore known in physics. The expression in equations of the problems of heat, looked upon in a mechanical point of view, leads, like all analogous problems, to an equation of partial differences of the second order, between several variables which are unknown functions of each other. These functions represent the true elementary physical laws which must be known in order to have the complete solution of the problem. The integration of the equation introduces arbitrary functions, the nature of which we must seek to discover by comparing the results given by the equation with those which direct experiments give, and with the laws derived from those experiments. Unhappily, in experiments on heat, direct experiments are rarely applicable to simple phenomena; generally, they attack complex questions which depend on several of these laws at a time, and most frequently it is difficult to assign the part which belongs to each of them. The experimenter must then endeavor to modify the circumstances under which he operates, so as to vary as far as possible in the respective experiments the parts which belong to each of the elementary phenomena, and to the law which expresses it. He will thus obtain equations of condition which may be of great aid for the discovery of a general theory; for this, whatever it may be, must always satisfy these equations.

This is the manner in which I have directed my researches, and I have always endeavored to define in the most precise way the conditions under which I was working, so that my experiments might be of service, whatever theory might finally prevail.

I published in 1847 the first part of my researches; they compose the second volume of the Memoirs of the Academy (of Sciences of Paris). Since that date I have not ceased to pursue them; but, the experiments which they required were so numerous, the numerical calculations so long and troublesome, that it would have been impossible for me to have executed them, if I had been left to my own individual efforts. I have been powerfully seconded by M. Izarn, who had already lent me his assistance for the first part of my work, and by a young engineer of mines, M. Descos, whom the minister of public works has kindly appointed my assistant for the last two years, in order to hasten the conclusion of my work. Let me be permitted thus publicly to express my thanks for the indefatigable zeal with which they have seconded me.

The subjects to which my new experiments have been directed are the following:

1st. The relations which exist between the temperatures and the elastic forces of a great number of saturated vapors, from the feeblest pressures up to 12 atmospheres.

2d. The elastic forces of these same vapors, saturated or not, in the gases.

3d. The elastic forces at saturation of the vapors produced by mixed liquids.

4th. The latent heat of these vapors under different pressures, from the feeblest up to those of 8 or 10 atmospheres.

5th. The latent heats of vaporization of the same substances, in gases.

6th. The specific heats of permanent gases and vapors under different pressures.

7th. The quantities of heat absorbed and disengaged by the compression and dilatation of gases, whether this dilatation takes place in a space whose capacity is augmented, or whether it takes place through a capillary opening in a thin wall, or by a long capillary tube.

8th. The quantities of heat absorbed by the gas when it produces, during its expansion, a motive force which is altogether consumed in the interior of the calorimeter, or is principally utilized elsewhere.

9th. And finally, the densities of saturated vapors under different pressures.

The experiments which have reference to these different questions, with the exception of the last one, are now nearly finished. But, as much time will still be required to put them in order, and discuss them with the proper care, I propose to present the general results, successively, to the Academy, while awaiting the time when I can publish them together.

I will present at present my researches on the calorific capacities of elastic fluids.

THE CAPACITIES FOR HEAT OF ELASTIC FLUIDS.

The specific heat of elastic fluids may be defined in two different ways; in the first, the specific heat of an elastic fluid is the quantity of heat which must be given to a gas to raise its temperature from 0° to 1° (Cent.), allowing it to dilate freely, so as to preserve a constant elasticity; in the second, it is the quantity of heat which must be given to it, to raise its temperature from 0° to 1°, forcing it to keep its volume, its elastic force increasing.

The first of these has been called the specific heat of a gas under constant pressure; the second, specific heat of a gas under constant volume. The first definition, only, coincides with that which has been admitted for the capacity for heat of solid and liquid bodies; it is also the only one which has heretofore lent itself to direct experimental demonstration.

A great number of physicists have employed themselves during the last century in the examination of the specific heats of elastic fluids; Crawford, Lavoisier and Laplace, Dalton, Clement and Desormes, De la Roche and Berard, Haycrafft, Gay-Lussac, Dulong, De la Rive and Marcet, have successively published researches on this subject. The greater part of these physicists have sought to demonstrate experimentally certain laws to which they had been led by the ideas which they had formed a priori as to the constitution of elastic fluids. They have applied themselves less to determine the numerical values of the calorific capacities of the different gases in relation to that of liquid water generally taken as unity, than to look for the simple relations which they supposed must exist among themselves. The conclusions to which they have come are generally very erroneous.

The work of De la Roche and Berard, which was crowned by the Academy in 1813, is still the most complete on this subject, and the one whose results differ the least from the truth. This superiority is caused, not only by the extreme care which these skilful experimenters exercised in their experiments, but also by the direct method which they followed; whilst the greater part of the other physicists had recourse to indirect methods, in which the element they sought exercised frequently but a very feeble influence.

The general conclusions which De la Roche and Berard drew from their labors were as follows:

1. The specific heats of the gases are not the same for all, whether we consider them in reference to volumes or to weights.

2. The capacity for heat of atmospheric air (that of water = 1) is 0·2669; that of the vapor of water 0·8470.

3. The specific heat of equal volumes of atmospheric air increases with the density, but in a less rapid progression. The ratio of the pressures being $\frac{1}{1·3583}$, that of the specific heats is $\frac{1}{1·2396}$.

4. De la Roche and Berard admit, on theoretic considerations, and resting, moreover, on direct experiments of Gay-Lussac, that the specific heat of the gas increases rapidly with the temperature.

These are the most precise notions on the specific heat of gases which we at present possess, and which are generally admitted by physicists. The limits within which I am obliged to confine myself in the present extract, prevent me from discussing the methods which have been adopted by my predecessors or to explain those which I have myself followed. I will merely say that I have met, in this kind of researches, great difficulties, not only in the experiments, but also in point of theory; the considerations which I have mentioned at the commencement of this article, will render them easily understood. Thus, although my first experiments are fifteen years old, and although I announced them at that epoch in the Memoirs on the specific heats of solids and liquids, it is only after using the most various methods, and after having forced the elements of their correction in opposite directions, that I now, with confidence, present my results to the Academy.

According to my experiments, the specific heat of air compared with that of water is

Between — 30° and + 10° (Cent.) 0·2377
" + 10° " 100° - 0·2379
" 100° " 225° - 0·2376

Thus, contrary to the experiments of Gay-Lussac, the specific heat of air does not vary sensibly with the temperature. Experiments made upon some other permanent gases led to a similar conclusion.

In experiments made upon atmospheric air, under pressures varying from 1 to 10 atmospheres, I found no sensible difference between the quantities of heat which the same mass of gas abandons in cooling, through the same number of degrees. Thus, in contradiction to the experiments of De la Roche and Berard, who found a very notable difference for pressures varying only from 1 to 1·3 atmospheres; the specific heat of the same mass of gas is independent of its density. Experiments made upon several other gases led me to analogous conclusions. I nevertheless present this law with some reserve; I cannot yet decide whether the capacity for heat under different pressures is absolutely constant, or whether it undergoes a very slight variation, because my experiments, perhaps, require a slight correction for the state of motion in which the gas was.

The specific heat 0·237 of the air, compared with water, is notably smaller than the number 0·2669, admitted by De la Roche and Berard; it is derived from more than 100 determinations made under different conditions.

The other elastic fluids whose specific heat I have determined are:

	Specific Heats.		
Simple Gases.	By Weight.	By Volume.	Densities.
Oxygen,	0·2182	0·2412	1·1056
Azote (Nitrogen),	0·2440	0·2370	0·9713
Hydrogen,	3·4046	0.2356	0·0692
Chlorine,	0·1214	0·2962	2·44
Bromine,	0·05518	0·2992	5·39

In casting the eyes over this table, it is immediately remarked that the specific heats of equal volumes of oxygen, azote, and hydrogen, differ very little from each other; so that we would be led to admit that the specific heat of the simple gases is the same when these gases are taken under the same volume and at the same pressure. But for chlorine and bromine, numbers have been found nearly equal to each other, but much greater than those which were obtained for the other simple gases.

	Specific Heats.		
Compound Gases.	By Weight.	By Volume.	Densities.
Protoxide of azote,	0·2238	0.3413	1·5250
Deutoxide "	0·2315	0·2406	1·0390
Oxide of carbon,	0·2479	0·2399	0·9674
Carbonic acid,	0·2164	0·3308	1·5290
Sulphuret of carbon,	0·1575	0·4146	2·6325
Sulphurous acid,	0·1553	0·3489	2·2470
Chlorhydric "	0·1845	0·2302	1.2474
Sulphydric "	0·2423	0·2886	1·1912
Ammonia (gas),	0·5080	0·2994	0·5894
Protocarburet of hydrogen,	0·5929	0.3277	0·5527
Bicarburet " "	0·3694	0.3572	0·9672
Vapor of Water,	0·4750	0.2950	0·6210
" Alcohol,	0·4513	0·7171	1·5890
" Ether,	0·4810	1·2296	2·5563
" Chlorhydric ether,	0·2737	0·6117	2·2350
" Bromhydric "	0·1816	0·6777	3·7316
" Sulphydric "	0·4005	1·2568	3·1380
" Cyanhydric "	0·4255	0·8293	1·9021
" Chloroform "	0·1568	0·8310	5·30
" Dutch liquid,	0·2293	0·7911	3·45
" Acetic ether,	0·4008	1·2184	3·04
" Acetone,	0·4125	0.8341	2·022
" Benzine,	0·3754	1·0114	2·6943
" Ess. of turpentine,	0·5061	2·3776	4·6978
" Chloride of Phosphorus,	0·1346	0·6386	4·7445
" " Arsenic,	0·1122	0·7013	6·2510
" " Silicium,	0·1329	0·7788	5·86
" " Tin,	0·0939	0·8639	9·2
" " Titanium	0.1263	0·8634	6·836

The specific heat which I have determined for the vapor of water by a great number of experiments, is 0·475; it is only about one-half of that found by De la Roche and Berard. It is very remarkable that the specific heat of the vapor of water is very nearly equal to that of ice or solid water, and only one-half of that of liquid water. —*Comptes Rendus de l'Academie des Sciences de Paris*, 18 *Avril*, 1853, *p.* 676. *Translated for the Journal of the Franklin Institute.*

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[From the American Railway Times.]

The Iron Trade of the United States.

PROBABLY in January, 1855, we shall have in the United States full 16,000 miles of railway in operation. Our railway building was commenced about 1830, and the progress has been pretty regular from that time, if we except the past year or two, when the percentage of increase has been large and rapid. In January 1, 1853, there were 13,847 miles of railway in operation, and 10,418 miles in construction. Of the last item it is not out of the way to say, that something like 3,000 miles will be finished in January, 1855. If we allow 100 tons per mile for ironing a single-track railway, this would give a total of 1,600,000 tons of railway bars, now or soon to be in use. But there is a very considerable amount of double-track railway in operation, and more in construction. Let us call that an extra hundred thousand tons—which is far below the actual fact—and we have a total amount of 1,700,000 tons. This, at $65 per ton, present prices, gives a total of $110,500,000 invested in railway bars in use. From experience, it is safe to set down the deterioration of the rail at eight per cent. per annum. We fear that our later importations will show even greater deteriorations. Eight per cent. wear and tear would be 128,000 tons per year, or over eight and one quarter millions dollars, and the amount for the ten subsequent years, allowing nothing for the double track, and nothing for increase of railway track, would be

1,280,000 tons, or $83,200,000. In our opinion, the sum of one hundred millions of dollars would come nearer the demand for this single item of railway wear and tear. We wish it to be understood, that we have purposely understated the amount of railway likely to be in operation in January, 1855. We have allowed nothing for double tracks, nothing for turn-outs, &c. By January, 1860, there will in all probability be in operation in the United States, 30,000 miles of railway. Between now and that period, we shall have to furnish the iron for some 16,000 miles of new track, and certainly as much as eight per cent. per annum of the amount now in use. Altogether it is rather a magnificent sum. We have said nothing of the multiplied uses of iron for cars, locomotives, steam-engines, machinery, steamboats, iron sailing-vessels, iron buildings, etc., which altogether go to swell the consumption to an almost unlimited amount. We have had something to say heretofore with regard to the importance of our iron manufactures, urging the present as the best moment for starting and extending their works, and trust they will do so. Hardly a day passes that we do not hear of some new iron enterprise, and we wish to impress upon the country the importance of sustaining it. We call upon the country to take this question of protection of our iron manufactures out of the vortex of party politics, and settle it upon its own merits. Nothing like protection is wanted now; but the time may come, when, in consequence of the organized movements of the foreign manufacturers, our manufacturers may need it. Let the country be wise, and give it. The present and prospective demand for iron, both in this and other countries, is so large, as to prevent any immediate falling off in prices. Let our manufacturers take heed of the opportunities of the next few years. By carefulness and economy, and with the aid they cannot but reap from experience, they will eventually be able to maintain themselves against foreign competition. Once established, we have the facilities for supplying our own consumption of iron, as we have long had of manufacturing our own cotton cloths. Almost every locality of the Union has iron and other ores. Some of the States are rich beyond value in this and other minerals. When our manufacturers reach the point of supply at a profit, they then begin to compete among themselves, and then the price drops to the mean and fair value. With the aid of new inventions and a few years experience, the iron manufacturers of this country have nothing to fear. But should the interest need fostering and protection against foreign competition—and we do not believe it will—the whole people are bound by self-interest to give it, and, as we believe, will give it.

Every part of our country has iron mines of great value. The Lake Superior Journal, in speaking of the Lake Superior Iron Mountains, says that their value is scarcely to be estimated. Their is iron enough, it says, and that of the best quality, to supply the wants of the entire country for centuries to come, and the wonderful deposits of this metal are beautifully situated in a wooded country, in the midst of a rich soil, with splendid streams, and waterfalls, and lakes; and all of these lands have been bought within half a dozen years at the government price, or ten shillings per acre; now their value cannot be estimated.

The great Middle and Northern States have all of them iron mines of incalculable value, and when once in operation, it will be no slight matter that will stop our rolling-mills and forges. Once fully started, the iron manufacturing interest will be strong enough to control all party machinery, because all the great industrial and manufacturing interests of the country will be bound with it. We regard this as the great interest of the country, and superior in real value to our gold mines a thousand times. We should foster, aid, and protect it. There is no particular need of our paying such tribute to Great Britain as we are now compelled to do, by buying a great proportion of our iron from her. The following table, showing the amount of iron made in that country at different periods since 1740, is instructive:

	Tons.
1740,	25,000
1796,	125,000
1802,	170,000
1828,	702,000
1839,	1,512,000
1852,	2,000,000

The amount for 1852, we have no doubt, is understated, but the aggregate for the past fifteen or twenty years must be enormous. It would add something to our national wealth, if we should manufacture any thing like this amount for home consumption or foreign export.

[From the American Iron Manufacturers' Journal.]

The Coal Supply.

The various statements put forth from the coal-mining districts, mostly to the effect, that the supply for the season would be insufficient, necessarily elicits a great deal of inquiry and solicitude. The mining operations and sources of supply have so multiplied the past few years, that it would be difficult to come to any settled knowledge of the true state of the case. With very little reflection, we can conceive what would seem the policy of the coal companies—to give as strong an impression as possible, that the supply would be insufficient, for the purpose of hurrying up the orders before the pressing season near the close of navigation, when the balances of stock and trade demands are quite plainly determined, and the chances of strong competition among themselves very probable. We state their policy in the strongest light, but must not be blinded, so as to be short-sighted, of possible contingencies. The use of coal as fuel has been much increased, and it is likely to bear comparison with the increased consumption of iron. The manufacture of anthracite iron has been much extended, and taking the home manufacture as equally increased with the importations, there is a consumption of nearly or quite fifty per cent. over the year 1852. It is impossible to give accurate figures, save in respect to the importations; but wherever we look into the domestic iron operations, we discover a corresponding increased activity. In respect to the domestic consumption of coal for home purposes, we know that, with the increased prosperity of the country, the comforts of home are multiplied, and that fuel makes one of the heaviest items. The uses of coal for general manufacturing purposes have, likewise, been much extended; and the steam navigation has received this year a vast addition to be supplied with a large amount. To these general facts, we must add the chances of heavy tolls for freightage, and if there is much of an extra late demand, vessels will expect a reasonable harvest. Thus looking upon all sides of the question, it seems reasonable to make sure of a supply at any rate. Probably at no past time has there been more uncertainty in respect to the probable balance which gives rise to speculation, or depressed sentiments according to their views. The figures published of shipments from old sources do not show a sufficient increase, but new companies have started new operations, and these are likely to make up for some of the increased demand. The anxiety of companies will probably anticipate nearly the required supply, and, if necessary, hurry up their operations to meet the demands. It is quite as reasonable, and even more so, to give these general points, as to quote the shipments of ten to twenty old companies, without the figures of the whole number of sources. The general rule has almost always proved a good one, to get in a supply early while shipping rates are low.

Cheap Stationary Engine.

The knowledge of the details of a cheap and substantial engine is often of great service. There is scarcely a town to which railroads have just penetrated, but has occasion for just such engines, and some enterprising builder soon finds it profitable to make a set of patterns for his own use and for that of his neighborhood. We have the notes of a very cheap, strong, and serviceable upright engine, which may be of use to some of our readers. The engine is of a kind particularly adapted for saw-mills, machine-shops, and foundries, sash and blind shops, &c. It occupies but very little space, and being very simple, requires but little expense for its operation and maintenance.

Cylinder 12 inches in diameter, 24 inch stroke; steam-ports 6 in. by 1 in.; exhaust-port 1½ in. wide. Cylinder is held by bottom flange only to a bed-plate, forming the connection of the columns of the frame, and is made tight by a lead joint. Weight of cylinder casting in rough, 564 lbs.

Frame is of two hollow columns connected by bed-plate at bottom, and cross-braces for pedestal seat near the top. There is a stout rib on under side of bed-plate, by which the bottom of the engine is held in a 16 inch timber, bolts being used to secure the engine only upon the square flanges on the tops of the columns. The columns are 4 feet from centre to centre; 12 feet 4¼ inches from bottom of bed-plate (exclusive of rib) to top of upper flanges; 10 feet 6 in. from bottom to seat of pedestal, and 11 feet ¾ in. to centre of shaft. Columns 8½ in. in diameter just above base mouldings, and 6½ inches at necks. Weight of frame casting 2915 lbs.

Wrought-iron shaft 4¾ inches diameter, and 7½ feet long; bearings 4⅝ in. diameter and 11 in. long, fly-wheel with flat rim to belt from, and is 8 feet in diameter, 14 in. face, and weighs about 2500 lbs.

Piston has cast-iron packing of two outer and one inner ring, each of ½ in. thickness. Piston-rod cut off 3 feet 11 inches in the rough. Connecting-rod 6 feet 3 inches long from centre to centre; bearing at crank end 2¾ inches diameter, 2¾ inches long; fork end at cross-head, each bearing being 2¼ inches diameter, and 2 inches long. Crank-pin held in crank by a flat key.

Eccentric is of variable throw by forming one eccentric within the other, the inner eccentric having 1⅝ inch throw, and outer one 2⅜ inches. The eccentrics are usually set to be adjustable at 3¼, 3½, or 4 inches throw. Lap of valve 1 inch. Regulator is of a simple pattern, secured to a bracket bolted to the frame. Steam-pipe is a 2¼ inch gas-pipe. Water-pipe from force-pump to boiler is 1¼ inch diameter. Boiler is 28 feet long, 42 inches in diameter; has 2 15 inch flues. Shell of boiler of ¼ inch iron, flues 3-16th inch. Cast-iron heads weighing 600 lbs. each. Entire boiler weighs 7000 lbs. Boiler is set between two 12 inch walls, 46 inches apart in clear. Under side of boiler 42 inches from hearth; and there is a flue beyond grate of 7 inches deep around lower half of the boiler. Grate 16 inches from bottom side of boiler.

To build this engine costs as follows:—

9000 lbs. castings, at 3 cents per lb., ...	$270 00
Finishing and setting up, ...	110 00
Boiler 7000 lbs., at 7 cents per lb., . . .	490 00
Forging, composition, and extras, . . .	180 00
	$1,050 00

Of late years there has been a great profit in building cheap stationary engines. During 1851, engines of the above specification could be built at a cost price of $850 to $875, while they would sell at the same time for $1,750. The erecting of the engine and setting of the boiler were always charged for as extras, by the builders. More than 500 engines of the above general description have already been built, by different makers, and have always given satisfaction, where an effective and economical engine was wanted.—*Am. Railroad Journal.*

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[For Appletons' Mechanics' Magazine.]

The Geology of the Present. The Mississippi Valley.

A DESIRE to see the bottom of the ocean laid bare has been experienced, and perhaps expressed, by almost every one who has gazed upon its surface. The imagination finds a wide field for speculations of the strangest character, on the revelations which would be made by uncovering the bed of any considerable portion. The few wrecks, anchors, bones, &c., in different stages of very slow decomposition; the scattered treasures of gold and silver, rigging, freight, &c., which may at first thought be supposed to form its chief attraction, give place on a little reflection to other considerations of a more philosophical and more deeply interesting nature. The bottom of the ocean, with the exception of a few slight currents, may be supposed to be in a state of perfect rest. The curling waves which lash its surface, and the long heavy swell which slowly rolls the floating bark, and thunders with sullen roar upon the beach, are alike ineffective at a very trifling depth; and the muddy rivers which mingle in this boundless reservoir, bearing the soil from the interior of every country under heaven, here calmly deposit their loads with the washings from the neighboring cliffs and shallows, where no telescope may survey, and nothing but the deep sea-lead can possibly disturb. There is a depth usually assumed at less than a half mile, below which, from various indications, neither animal nor vegetable life is supposed to exist in any form, or even fermentation and decay to proceed in the same manner as at the surface. Except under extraordinary emergencies, as when pursued like the whale by remorseless enemies, none are supposed to venture into the darkest bosom of the deep. Neither animalcule in its minutest form, nor scale-encrusted monster, basking in the freedom of the tempest, delight to descend to any considerable depths. Whether the immense pressure is inconsistent with organized existence, or whether the barrier consists in the absence of food and heat, or again the absence of the vivifying oxygen of the atmosphere, minute bubbles of which penetrate the surface, and supply the narrow lungs, are speculations purely physiological, and aside from the object of our present inquiry.

The ocean and seas being the common receptacles of all our streams, and giving back nothing but the purest water by evaporation, must gradually deposit upon their bottoms matter varying in amount, color, and character with the locality, and also with the period of time. Water in one locality, which has been depositing but the finest clay, and in the most homœopathic quantities, becomes, by a temporary freshet, or the changing of the embouchure of a river, loaded with a coarser gravel, which is again exchanged, perhaps, for centuries of almost absolute purity. These changes would so clearly result in the production of strata like those observed on many parts of the dry and substantial lands around us, that careful examiners have little hesitation in pronouncing that every acre of the habitable world has been in turn, perhaps repeatedly, the bed of great bodies of water, sometimes fresh, sometimes salt and containing remains of marine animals, and again brackish and presenting features partaking of this mixed condition. This is but a familiar method of arriving at conclusions now more firmly established by each additional discovery in geological science, that every grain of earth yet examined has been influenced in its present form either by volcanic heat or aqueous deposit, acting through longer or shorter periods; and however much it may outrage our unenlightened prejudices, terms indicating these derivations, together with others pointing to a probable combination of both, are now parts and parcels of the creed of every attentive mind, assuming to search these most sublime and lasting monuments, and to "look through nature up to nature's God."

The length of time that would be required thus to revise and re-shape over and over the surface of our planet, by gradual alternations of quiet subsidence or emergence cannot well be conceived. Geologists have relinquished, in a great degree, their early theories of sudden and violent upheavals of continents, and the production of immense waves in consequence; and in view of the fact, that various portions of the earth's present surface are either emerging from or sinking into the sea, have tacitly consented to ascribe most of the results to such earthquakes and more gradual changes as are now progressing. Within the period of a few thousand years, embraced by the records of history, the plains of Sodom and Gomorrah have been plunged far below the level of the sea; coral reefs have emerged from the waves by the industry of minute insects, and been clothed with vegetation; volcanoes have arisen from the depths, thrown up millions of tons above the great sea level, and expired; and in one case, some hundreds of miles of the western coast of South America was raised several feet vertically, and so remains at this moment. Nor is it alone in the torrid zone, and the regions of earthquakes and tempests, that these effects of some great cause are constantly transpiring. Lands in the coldest regions of America are found to be sinking quietly beneath the water, while the North of Europe, the home of the equally frigid Laplander, is rising in some places at the rate of nearly five feet per century.

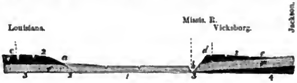
These gradual changes, taken in connection with a variable or migratory subterranean heat, are considered sufficient to account for most of the changes marked on the surface of our planet. The gradual elevations or depressions are interrupted by long stationary periods, in which condition we find the mass of the continents and islands at the present day. There is a constant temptation to believe, as we find layer after layer deposited in almost every position, that the solid matter of the earth has been increased, that it has received additions of matter from some external source, that "meteoric showers" were once quite frequent and heavy, or that our planet has been made a target against which many and sundry wandering comets have impinged and added to its mass some score of layers in each million years; but such is not necessarily the case. To the aqueous and igneous agencies before mentioned, together with the movements of masses by attachment to icebergs, glaciers, &c., may be ascribed all the varieties of matter and of position which, under the harsh names peculiar to geology, have been made the study of the profoundest of modern intellects. The formation of fused masses is as real in the heart as on the surface of the volcano, and the effects of volcanic heat, now melting into fluid the solid strata miles beneath the surface, may become apparent in ledges of granite, when ages shall have washed away and redeposited the superincumbent earth.

Reasoning from analogy, and from certain positive indications, the formations, whether by water, or heat, or compounded of each, indicate successive periods, and in this sense the layers may be said to resemble the piles of volumes in a badly-arranged library. Geology has been poetically and yet truthfully termed "the world's history of itself;"—a history far from complete—containing many a hiatus and interregnum, but yet free from many of the fables, allegories, and prejudices of written history. Ages on ages are supposed to have elapsed prior to the existence of animal life, successive periods developed strange forms long since extinct, which succeeded each other with gradual approaches to the present forms, until the modern strata include in their deposits bones of men and animals now living on the surface. In the island of San Lorenzo, near Lima, Mr. C. Darwin found, at the altitude of 85 feet above the sea, shells of species now swarming in the neighboring seas; part of a stalk of indian corn, plaited rush, and even cotton thread; and the neighboring main land bears similar indications, that the bed of the ocean has been uplifted bodily to a height of 85 feet above its present surface, since the region was peopled by the Peruvian race. A somewhat similar instance of recent deposit, but containing a striking proof of its tolerable antiquity, may be found in the fact, that the Vatican and Capitol in the venerable city of Rome, on elevations of some 200 feet above the plain of the Tiber, are on a foundation containing, amongst remains of some extinct species, shells of marine animals now existing in the Mediterranean. Near Stockholm, in Sweden, horizontal beds of sand, loam, and marl, contain the same assemblage of shell-fish as now live in the brackish waters of the Baltic, mingled with which remains are some rude works of art, and portions of vessels built before the introduction of iron; the whole marine formation having been upraised, so that the upper beds are some 60 feet higher than the water. In the island of Guadaloupe, West Indies, a solid limestone occurs at the level of the sea beach, enveloping human skeletons with entire corals and shells, fragments of pottery, arrow-heads, and other indications of its recent date. A limestone, with similar contents, has been formed, and is still forming, in St. Domingo, although, in general, these very recent formations form a small and very unimportant portion of the earth's surface.

Having thus arrived at a general and comprehensive glance at the changes continually progressing, attention may now be centred on the present Mississippi Valley, as exhibited by the surveys of Mr. Ellet and others, within the few years past. Sir Charles Lyell, in his second visit to the United States, in 1845, devoted a considerable degree of attention to this region, which is thus alluded to in his "Manual of Geology," just republished in this country, and from which, as the latest and perhaps highest authority extant, a large proportion of the preceding data has been drawn.

"Suppose part of a continent, comprising within it a large hydrographical basin like that of the Mississippi, to subside several inches or feet in a century, as the west coast of Greenland, extending 600 miles north and south, has been sinking for three or four centuries, between the latitudes 60° and 69° N. There might be no encroachment of the sea at the river's mouth, in consequence of this change of level, but the fall of the waters flowing from the interior being lessened, the main river and its tributaries would have less power to carry down to its delta, and to discharge into the ocean, the sedimentary matter with which they are annually loaded. They would all begin to raise their channels and alluvial plains by depositing in them the heavier sand and pebbles washed down from the upland country, and this operation would take place most effectively, if the amount of subsidence in the interior was unequal, and especially if, on the whole, it exceeded that of the region near the sea. If, then, the same area of land be again upheaved to its former height, the fall, and consequently the velocity of every river would begin to augment. Each of them would be less given to overflow its alluvial plain; and their power of carrying earthy matter seaward, and of scouring out and deepening their channels, would continue, till after a lapse of many thousand years, each of them would have eroded a new channel or valley through a fluviatile formation of modern date. The surface of what was once the river-plane at the period of greatest depression, would remain fringing the valley sides in the form of a terrace apparently flat, but in reality sloping down with the general inclination of the river. Every where this terrace would present cliffs of gravel and sand, facing the river. That such a series of movements has actually taken place in the main valley of the Mississippi and in its tributary valleys during oscillations of level, I have endeavored to show in my description of that country;* and the freshwater shells of existing species and bones of land quadrupeds, partly of existing races preserved in the terraces of fluviatile origin, attest the exclusion of the sea during the whole process of filling up and partial re-excavation."

"The accumulation of fluviatile matter in a delta, during a slow subsidence, may raise the newly-gained land superficially at the same rate at which its foundations sink, so that these may go down hundreds or thousands of feet perpendicularly, and yet the sea bordering the delta may always be excluded, the whole deposit continuing to be terrestrial or freshwater in character. This appears to have happened in the deltas both of the Po and Ganges, for recent artesian borings, penetrating to the depth of 400 feet, have there shown that fluviatile strata, with shells of recent species, together with ancient surfaces of land supporting turf and forests, are depressed hundreds of feet below the sea level.† Should these countries be once more slowly upraised, the rivers would carve out valleys through the horizontal and unconsolidated strata as they rose, sweeping away the greater portion of them, and leaving mere fragments in the shape of terraces skirting newly-formed alluvial plains, as monuments of the former levels at which the rivers ran. Of this nature are "the bluffs," or river cliffs, now, bounding the valley of the Mississippi through a large portion of its course. Thus let *a b*, fig. 106, represent the alluvial plain of the Mississippi, a plain which, at the point alluded to, is more than thirty miles broad, and is truly a prolongation of the modern delta of that river. It is bounded by bluffs, the upper portions of which consist, both on the east and west side, of shelly loam, No. 2, rising from 100 to 200 feet above the level of the plain, and containing land and freshwater shells of the genera *Helix*, *Pupa*, *Succinea*, and *Lymnea*, of the same species as those now inhabiting the neighboring forests and swamps. In the same loam also, No. 2, are found the bones of the Mastodon, Elephant, Megalonyx, and other extinct quadrupeds.



Valley of the Mississippi.

"I have endeavored to show that the deposits forming the delta and alluvial plain of the Mississippi consist of sedimentary matter, extending over an area of 30,000 square miles, and known in some parts to be several hundred feet deep. Although we cannot estimate correctly how many years it may have required for the river to bring down from the upper country so large a quantity of earthy matter—the data for such a computation being as yet incomplete—we may still approximate to a maximum of the time which such an operation must have taken, by ascertaining experimentally the annual discharge of water by the Mississippi, and the mean annual amount of solid matter contained in its waters. The lowest estimate of the time required would lead us to assign a high antiquity, amounting to many tens of thousands of years to the existing delta, the origin of which is nevertheless an event of yesterday, when contrasted with those terraces, *c*, and *d e*, fig. 106, formed of the loam No. 2 above mentioned. These materials of the bluffs *a* and *d* were produced, the reader will observe, during the first part of that great oscillation of level which depressed to a depth of 200 feet a larger area than the modern delta and plain of the Mississippi, and then restored the region to its former position."

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* Second Visit to the U. S., vol. ii. chap. 34. † See Principles, 8th ed. pp. 260-265.

The Mechanical Action of Heat.

(Translated for Appletons' Mechanics' Magazine from L'Illustration.)

When a body is exposed to the action of heat, there is produced the phenomena of dilatation, that physiciens explain by saying that the caloric has penetrated the body, and taken the place of the air, or water, or any other substance interposed in the pores of the body. In order to penetrate a body thus, the caloric has had to overcome a certain resistance, and to exert a mechanical action (*action mécanique*). In consequence, caloric is a force that can be utilized in the arts, and in machines identical with the steam-engine. It is this idea that Captain Ericsson is endeavoring to realize in his new Caloric Engine. The idea of Captain Ericsson is not new: in 1824, M. S. Carnot published, under the title of "Reflections on the Motive Power of Heat," a work explaining the principal phenomena due to this agent, but which introduced grave errors, which have long existed in science, and which are not entirely got rid of yet. We will give them below in a few words.

In the explanation of the mechanical action of heat, M. Carnot set forth, that "the effect produced was due to the passage of the caloric across the motor, and that in consequence there was no loss of the fluid. Caloric acts in a manner analogous to the water that moves a water-wheel, and of which the motive power depends on the difference of level that determines the flow. In applying this reasoning to the steam-engine, the boiler may be compared to the head of water, and the condenser in some sort to the inferior basin. To complete the analogy, the word *fall* might be used to express the passage of the heat from the boiler to the condenser, and the height of the fall would correspond to the difference of temperatures."

At the epoch of M. Carnot, this first fact was accepted on his assertion, and it was not even attempted to try by experiments, whether the temperature was preserved in the steam before and after the accomplishment of the work. M. Regnault himself had not this blind confidence; and from the most precise measures, he found that, in a machine of expansion, without condensation, where the steam entered at 5 atmospheres, and left at zero (of pressure), the quantity of heat possessed by the steam on entering was 653 units, and on leaving 637. In a condensing machine the difference was still more sensible, the number 653 being reduced to 619. In the first case there was a loss of 16 units, and in the second a loss of 34.

M. Carnot also asserted that the quantities of heat disengaged or absorbed by the same elastic fluid, only depended on the initial and final conditions of temperature and pressure, and that they were entirely independent of the intermediate circumstances through which the fluid passed.

M. Joule has tried an experiment, which has the approval of M. Regnault, in order to demonstrate the falsity of this assertion. The following are the details of this ingenious experiment.

In the first place, air was compressed in a reservoir to a tension of ten atmospheres; the reservoir thus charged was placed in a calorimeter; suddenly the capacity of the reservoir was doubled, the pressure descending to 5 atmospheres, and this dilatation produced a cold appreciable to the thermometer.

In the next place, there were placed in the same calorimeter two reservoirs, of the same capacity; in one, air was compressed as before to 10 atmospheres, and in the other was a vacuum. A communication was suddenly formed between the two vessels, and, if regard was only had to the initial and final conditions of the operation, a lowering of temperature should take place, the same as in the preceding case—the pressure, of course, in both, descending to 5 atmospheres (neglecting the contraction from loss of heat in the first). But this falling did not take place, the thermometer remaining perfectly fixed.

All these facts prove, that it is necessary to abandon the ancient theory, and accept in place of it a new one which will better explain known phenomena. This new theory recognizes that a certain quantity of heat is lost, or, rather, that it is transformed into quantity of action, and that the work produced is proportional to the amount of caloric expended. By referring to the facts given above by M. Regnault, upon the different temperatures of steam before and after accomplishment of work, one will see that the loss of heat in a machine of expansion, without condensation, is one-fortieth, while it is one-twentieth in a condensing machine, which has an economic value much more considerable than the first: in other terms, the machine without condensation, which produces less work, only loses one-fortieth of its heat; while the loss is elevated to one-twentieth in the condensing machine, which accomplishes much more work. In the experiment of M. Joule, the lowering of temperature in the first instance is explained by the effort which the sides of the reservoir were subjected to, and which would be capable of raising a weight outside of the calorimeter; while, in the second instance, the air passing from one vessel to the other experiences no resistance, and, in consequence, accomplishes no work. [The writer leaves this rather obscure. Suppose, in the first experiment he alludes to of M. Joule, the reservoir had been a cylinder with a piston fitted to it (as it probably was), and the capacity had been doubled by allowing the piston to move over the distance necessary for that purpose. It is evident that we here have a certain pressure (which could be calculated by the ordinary methods of using steam expansively), acting through a certain space. This is what constitutes Quantity of Action, or Work. It is thus plain that the air, in being allowed to expand, accomplishes an amount of work which could be calculated by any steam-engineer. In the other experiment, the air in passing from one vessel to the other, although the initial and final conditions of pressure were the same (neglecting, of course, the loss of pressure from the decrease of temperature in the first instance, this being a depending, not an affecting condition), could accomplish no work, there being no appreciable motion.]

If, now, in looking at this fact, that in machines in which heat is the agent, the caloric has need of an intermediate substance, of a vehicle to circulate in, and which vehicle is ordinarily an elastic fluid, as gas, or steam, either saturated or not, one will comprehend how important it is to know the quantity of heat that ought to enter or leave the different vehicles, in order to change them from one temperature to another.

This determination, easy for solids and liquids, is almost impossible for gases, for with them it is necessary to consider two kinds of specific heat,—the specific heat under a constant pressure, and the specific heat under a constant volume. The determination of the specific heat of gas under a constant pressure, has given rise to investigations by several different authors, the most important of which are those of MM. Delaroche and Bérard; while the determination of the specific heat of the same bodies under a constant volume, has highly excited the attention of experimenters, without drawing any direct results, for, the gas being obliged to be inclosed in an inextensible vessel, the heat which enters it is but a small part of that which the vessel takes.

It is in reasoning *a priori*, and from some experiments of Gay Lussac, that it has been admitted that the specific heat of gas, under the same volume, augments with the pressure and the temperature.

M. Regnault has submitted to a new examination the calculations of his predecessors, and has dispersed these useless variations. Gases are not species of sponges which are impregnated with caloric, but each molecule heats by itself, without regard to the distance it is from its neighbors; and if the gas in enlarging the bounds which inclose it (*en repoussant les parois qui le renferment*) falls in temperature, it is only necessary to see in this loss of caloric a phenomenon purely mechanical (*purement mécanique*), and this lost heat must be sought for in the work produced.

FELIX RONBAUD.

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Proceedings of the National Scientific Convention.

The American Association for the Advancement of Science commenced its seventh annual convention at Cleveland, Ohio, July 29, the meetings being continued for four days. The eighth annual meeting will be in Washington, D. C. Professor James D. Dana, of New Haven, Conn., was elected President; Prof. Joseph Lovering, of Cambridge, Mass., Permanent Secretary; Prof. J. Lawrence Smith, General Secretary; Dr. A. L. Elwyn, Treasurer; Drs. Halderman, Leidy, and Le Conte, Auditing Committee.

About 80 papers were read, several of which have already appeared in the daily newspapers. We have only space in this number for the following sketches, which have been revised and corrected for our columns.

ON COHESION OF FLUIDS, EVAPORATION, AND STEAM-BOILER EXPLOSIONS.

By Lieut. E. B. HUNT, U. S. Topographical Engineer.

I now wish to present a simple exposition of the mechanical theory of cohesion in fluid masses, and from this to deduce the structure of a fluid surface, showing that its cohesive strength is much less than that of the interior layers. This result furnishes a clear and direct explanation of the great fact of evaporation, and shows why, in all cases, even in ebullition, evaporation is a strictly surface phenomenon. Hence follows an explanation of one of the chief causes of steam-boiler explosions, and the easy suggestion of a very practical remedy; also, an explanation of the heating of fluids to high temperatures, as observed by Donny, and of the entire agency of contained air in ebullition.

Several years have now elapsed since, in tracing out the results of a highly general theory of molecular mechanics, it occurred to me to call in question the commonly received views as to the amount and character of fluid cohesion. Regarding all cohesion directly a function of the distance between adjacent molecules, it was quite impossible to imagine that the exceedingly small difference of the intermolecular distances, corresponding to the fluid and solid forms respectively in any given substance, could produce that very great difference of cohesive strength, so generally conceived to exist. The slight difference of volume, for instance, between a solid and fluid pound of iron, would not lead me to anticipate any marked difference of cohesion, so long as we regard this cohesion as any tolerably simple function of the intermolecular distance.

The ordinary experiments, professing to measure fluid cohesion, are by no means cases of direct rupture, and, indeed, furnish no measure whatever of actual cohesive strength. The common experiment of separating, by counterpoising weights, a disc from a fluid which wets it, furnishes no indication of the cohesion in the mass of fluid, but merely shows the force required to break the fluid surface. Donny's experiments show positively that the yielding is here entirely at the surface, progressing through the mass by the successive breaking of the successively-formed surfaces, only a mere fluid filament being at last broken by direct rupture. It is truly a case of capillary action between a horizontal fluid surface, and a horizontal circular solid surface, and, like all other capillary action, exists primarily at the surface only. Except in the frequently-observed adhesion of well-boiled mercury in barometer tubes, to heights far above the true barometric level, we have, in fact, no record of any experiments exhibiting the resistance offered by a fluid mass to direct rupture, which only ought to be taken as a true measure of cohesion. All the common views of a slight fluid cohesion are based on erroneous interpretation, in which the effects of the easy mobility of parts in fluids are very loosely imputed to a low value of cohesion. Once clearly understanding that surface-yielding gives no measure of cohesion or direct resistance to rupture, we can readily see that the prevalent ideas on this subject are without support.

If we study the phenomena attending the condensation of gases and vapors into fluid, it is apparent, that while contiguous molecules are still at distances many times as great as that characterizing the fluid state, the cohesive attraction manifests itself appreciably. Steam instantly condensing at the rate of a foot of steam to an inch of water, shows that in water the cohesive action of a molecule extends effectively through a sphere whose diameter is at least twelve times the distance between adjacent molecular centres in the fluid. Hence in water, the radius of effective cohesive action must be so great as to include several molecular layers. The moment a gas ceases to follow Marriotte's law, cohesive action becomes appreciable, and this is proof enough that in masses many layers contribute their action in making up the total cohesion. If we conceive any fluid mass to be distributed into layers, then the correct measure of fluid cohesion will be the force requisite to produce a direct simultaneous separation of all the parts along a unit of the dividing surface between two layers. This is equal to the resultant of all the forces acting from either direction against this unit of surface, these being held in equilibrio by the equal opposing forces.

[Lieut. Hunt introduced a mathematical expression, from which he deduced the following conclusions.]

This formula involves no particular hypothesis, as to the value or character of the forces acting, only that the aggregate is attractive. But as condensation is a spontaneous phenomenon through all that portion of aggregational range in which energetic action are found, we ought to assume that all the effective terms are attractive. To present the grounds which seem to me to authorize the conception, that repulsion in all states of aggregation is only exercised between adjacent molecules, while the attractive actions are the resultant of all the primary constitutional forces, and extend through longer spheres, would involve the exposition of a complete theory of molecular mechanics. I must therefore leave as an assumption the conception that in fluids, the only repulsion to be taken into account is the continuous layers, which prevents their yielding farther to the cohesive forces pressing them together.

We should observe that, in consequence of the deficiency of cohesion along the fluid surface, a refraction would take place which would again diminish surface cohesion, to a considerable extent below that value given by the formula.

[Lieut. Hunt here applied the general formula to a surface-element, in order to determine the cohesion measured along a surface. The result thus reached, in respect to a mass *in vacuo*, would not be greatly affected in the ordinary atmosphere.]

It is somewhat remarkable that Poisson's capillary theory, as stated by Mossotti, in *Taylor's Scientific Memoirs*, is based essentially on an analysis of the fluid surface, in which the halfing of the normal layer is totally overlooked, and the cohesion along the surface is declared to be the same as in the mass, the surface layer only having been taken into account. I have not seen Poisson's work, but it is singular that Mossotti should either have made such an oversight, or have failed to detect it in Poisson, if he really committed it. It is a radical defect, even using Poisson's own hypothesis, and must directly affect, or even invalidate, his whole theory.

I come now to an important deduction from the preceding discussion. Fluid surfaces are in a state of weak cohesion, as compared with fluid interiors; hence, a partially atmospheric condition of rarefaction exists along such bounding surfaces. If, then, we assimilate heat to a molecular repulsion, as is customary, we see at once that, as the temperature is raised, the weak cohesion in the surface will be overcome, long before the mass is heated to that point which will overmaster its internal cohesion. Hence the surface molecules will freely pass off as vapors, while a strong cohesion still exists throughout the entire mass. Evaporation thus goes on at surface at all temperatures above that which just suffices to overcome the weak surface cohesion. This constitution, or structure, necessarily characterizing the limiting layers of fluids, is the true and full explanation of evaporation in all its forms. From this we see that a fluid mass, without interior or exterior surfaces, or so inclosed as virtually to answer this description, might be heated up far above the boiling-point without boiling. We see that ebullition is but the effect of an internal evaporation, starting in minute air-bubbles, and growing with the expanding bubble. We see that water, entirely freed from air-bubbles, and with a restricted open surface, as in Donny's tube experiments, should go on heating up far above the boiling point, until at last the whole heated mass would flash into steam with an explosion. All the phenomena described by Donny, in his excellent paper in the *Annales de Chimie et de Physique*, follow as easy and obvious deductions from this constitution of the fluid surface. Indeed, we do not at all wonder at his being forced, from his experiments, to conclude empirically that there must be some peculiar quality in surfaces which makes evaporation take place so much more readily on them than on fluid masses. We see, too, how utterly fallacious are the experiments usually taken as measuring fluid cohesion in surface layers, which, with the free mobility of fluid parts, fully explains all the observed results. This fully explains how a too perfect boiling of the mercury in barometer tubes makes it adhere at the top with such tenacity. It explains Berthollot's experiment on the forced dilatation of fluids, in which a deaerated fluid, sealed when hot, does not shrink when cooling for a long time, but at last breaks and collapses, indicating that it has borne a great tension before yielding. Prof. Henry's elegant experiments with soap-bubbles—in which, by measuring the tension of the inclosed air, he is able to deduce, first, the compressing force, and then the cohesion of the fluid film—will furnish an independent confirmation of the same general views. We may remark that the heterogeneous structure of the outer layers would destroy the mobility of their parts, and give a film-like character to the fluid surfaces, while all within the film would have free mobility. This, with the additional fact of a drawing inward of the outward layers by the unbalanced cohesive action of the layers near the surface, explains the great variety of formal phenomena exhibited by drops, bubbles, and fluid surfaces.

About forty years since, I conceived the idea of directly measuring fluid cohesion, by rupturing a pure fluid column in a cylinder with a moving piston. By filling the cylinder with the fluid to be tested, and immersing the piston, by the aid of a valve closing at will, the force requisite for starting the piston will be the cohesion of the column, on allowing for atmospheric pressure. Of course the fluid must adhere to the cylinder more strongly than it coheres in itself, else the adhesion only would be measured. Nor must it contain any air-bubbles, as the presence of one such, however small, will give a start to the break, by presenting a weak surface. This is the great difficulty of the proposed experiment. In May last, I had just begun such an experiment on mercury, in an amalgamated cylinder, but the requisite precautions for excluding air could not be taken for lack of time, as I was obliged to leave my station before the apparatus was quite completed. The rapidity with which the mercury rushed past the piston, in the rough trial made, showed that some packing will probably be requisite to a deliberate measurement; and this again will present the difficulty of introducing an amalgamated surface in the mass to be broken. The precautions requisite for a perfect trial of the experiment are quite numerous.

I anticipate that exceeding small air-bubbles will have the effect of making the indications irregular, as the smallest bubbles will only start a break on the application of very considerable force.

I will now apply this discussion to *steam-boiler explosions*. The condition requisite for ebullition in boiling water, is simply that air-bubbles in the heated portions shall present on their borders the weakly coherent surfaces requisite for evaporation to be established. Perfectly deaerated water, with a limited surface, would not boil at all, but would steadily heat up until it reached that point at which it would flash explosively into steam. Now, one chief cause of local explosions is clearly of this description. The boat stops at a wharf; the "doctor," or pump supplying water to the engine, being worked by the engine itself, stops its water supply when the engine stops. The water in the boiler goes on boiling until all the air-bubbles are boiled off from the water, and their air is mixed with the steam above. Then there ceases to be any evaporating surface, except that on the top layer, which is farthest from the heating surface, and quite inadequate to the consumption of all the heat supplied. Then the mass of water begins to heat up, and it goes on storing up the unconsumed caloric, until the water is far hotter than the head of steam would indicate. The engineer then starts the engine; this starts the pump, which throws a stream of water charged with air directly into the glowing fluid. The heat instantly finds its outlet by an overwhelming evaporation on the newly-supplied bubble surfaces, and a tumultuous ebullition follows. The gathered store of heat flashes off a portion of the water into steam of excessive tension—a tension such as nothing can withstand. The terrific consequences are too often witnessed in those fatal catastrophes, which have given to our western rivers such a tragic reputation.

No one can examine a list of western steamboat explosions, without being forcibly impressed with the frequency of these accidents just as the boat is starting from the wharf after landing. It seems to me beyond doubt that many of these occur just in the manner now stated, and from the deficiency of air-bubbles in the boiler. We see in this reasoning, too, a sufficient explanation of dry steam; or steam hotter than its tension indicates. The heating is then going on faster than the evaporation, and the steam is thus heated as if it were not in contact with the water, or were in a vessel by itself. It is not always that the remedy for a danger is as obvious and easily applied as in this case. It is only necessary to keep the pump in steady, slow operation while the engine is at rest. It should always be capable of an independent movement, and should constantly, while a boat is going be kept at work, however slowly. By this means, air for ebullition will always be supplied, and the accumulation of heat in a sluggish mass of water cannot then go on until the explosive point is reached.

The field over which I have thus rapidly traversed, is one requiring much practical study for its full development and illustration. I could not here give all which belongs to it without exceeding reasonable limits. Nearly all the views which I have presented, were the result of my own studies, so far as concerned my original acquaintance with them. But I was happy to find that Donny and Henry had, in some points, reached the same conclusions by independent routes. But I am not aware that any one has presented the same analysis of cohesion, or of the molecular constitution of material surfaces. Especially does the derivation of evaporation from molecular mechanics seem to me novel and worthy of careful consideration. Donny indicates deaeration as a cause of steam-boiler explosions; but it is essentially as an experimental deduction, and not connected with its mechanical derivation.

In conclusion, I will present an outline of a most interesting illustration of creative design in the earth's co-ordination. The explanation of evaporation which has been given, shows that for each fluid the formation of vapor lies within certain definite limits of temperature, as a result of its primary structure. These limits differ greatly in different fluids. Now, in framing the earth for habitation, or for the proper life of animal and vegetable forms, something equivalent to rain was necessary from the constant descent of fluids to the lowest level. Without some agency to lift the great organic fluids above the ocean bed, sterility would have been the lot of all which rose above its surface, and terrestrial organism would have been quite impossible. But fluidity does not involve evaporation, except within certain definite limits, special for each liquid. Again, evaporation might go on, and yet no capacity for condensation exist, except within other limits of temperature quite unattainable, save through special arrangement. Rain, then, with our earth and atmosphere, involved a special constitution of the raining fluid, not only so that co-operation at ordinary temperatures should go on, but so that condensation may again take place in the ordinary air. Not only must this qualitative arrangement exist, but also a quantitative one, since the quantity of rain best sufficing to the aggregate organic need, is exactly a certain definite number of inches per annum. Now, water is doubtless the only known liquid which could by possibility answer these definite mechanical conditions. Hence we say, that there is a peculiarly clear evidence of design. First, in making a fluid which could under our cosmical conditions undergo the raining round; and, secondly, in its being on the earth in so exactly the quantity best meeting the aggregate organic needs. Ether, quicksilver, or any other known fluid, could not, in any possible arrangement of quantity, supply this primary cosmical necessity. Now, when we reflect how many are the instances in which the terrestrial elements—simple and in combination—exist in strict accommodation to organic needs, both qualitatively and quantitatively, the cumulative evidence of design is as apparent as that furnished by a locomotive or a cotton-mill. Not only is organic life found in strict relation to the earth, but the earth is also primarily constituted in strict relation to organic life. Let whoever doubt this study the extremely slender *a priori* chance that a drop of rain, of any liquid, should ever fall upon the earth; and let him but picture the total lack of all animal life which must have followed any cast of the die other than that really existing. Life, without fluid circulation, is totally inconceivable by the mind of man; and exactly to determine the appropriate kind and quality of liquid, as has been done in the real frame of nature, was a problem of pure and absolute intellection, transcending the grasp of every mind, save the all-wise creating Designer.

ON THE RESISTANCE OF VERTICAL PLATES OF TUBULAR BRIDGES.

By **Hermann Haupt**, Superintendent Penn. Central Railroad.

The great desideratum in the construction of bridges is an arrangement of parts that, with a given weight of material, will possess the most efficient power of resistance. An arch fulfils the condition of maximum resistance with a given weight of material, when the distribution of the weight is constant. With a permanent weight, whether uniformly distributed or not, there is a curve of equilibrium, and a given amount of weight of material, arranged to conform to this curve, will give the maximum of resistance which the material is capable of opposing; but for ordinary bridges, especially for railroad purposes, there can be no curve of equilibrium; the load is not only variable, but very great in proportion to the weight of the structure; and were an equilibrium possible in one position, it could remain stable for an instant only, as the transit of the load to another position would at once disturb it.

It is evident, therefore, that the principle of equilibration applies only to aqueducts, or other structures upon which the loads are nearly constant, and that to render an arch capable of sustaining a variable load, it must either be made so deep that the variations of the curve of pressure will never pass outside the arch, or it must be combined with a resisting truss capable of effecting or opposing any tendency to change of figure.

Most of the bridges in general use are illustrations of this species of combinations; but the main reliance is usually placed upon the truss, the arch being used merely as an auxiliary.

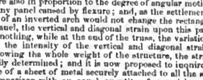
When wood is used, this increase of material is not objectionable, except so far as it increases unnecessarily the weight of the structure; but when iron is employed, it becomes essentially important that the distribution of the forces should be understood; the strain upon all the parts of the structure accurately determined, and the dimensions correctly proportioned to the required resistance.

The principles involved in these calculations have already been given to the public, in a work on the general theory of bridge construction; and no further reference to them is required, except to state that an application of these principles would lead to a radical change in the manner of constructing bridge trusses; and instead of using an arch as an auxiliary to a truss, the arch would be made a chief dependence, and the truss employed to resist the action of the variable loads, and to prevent changes of figure in the arch during their passage over the bridge. When disposed in this manner, a given quantity of material will oppose an efficient resistance either to vibration, flexure, or fracture.

In tubular iron bridges, which have recently attracted much attention, no difficulty is found in determining the strain upon the horizontal tables, and in proportioning them correctly; but the dimensions of the vertical ribs, and the best manner of stiffening them, will depend not only on the magnitude of the weight, but upon the mode of the application. If the weight supposed be applied at the middle of a tubular bridge, its action would tend to shorten the diagonal extending from the middle of the top cord or cable to the end of the bottom table, and at the same time to elongate the opposite diagonal from the middle of the bottom table to the end of the top table; as the strain upon the last diagonal would be tensile, its ability to resist would be nearly as the strength of the material, but the opposite diagonal, being subjected to compressive forces, would, if it formed a line of a thin plate of metal, be unable to oppose any efficient resistance, and the bridge would probably fail in the direction of this diagonal.

It becomes necessary, therefore, to provide means for stiffening the ribs, and this is usually effected by riveting to them, vertically, pieces of T iron, at short intervals. By these additions, the distribution of the strains is changed, and the action of the parts is similar to that of a truss on the Pratt plan; the vertical stiffeners taking the place of the parts, and the lines of short iron connecting the opposite angles of any panel having a corresponding action to the ordinary diagonal rods. The resistance which such an arrangement is capable of opposing, it is proposed to determine from the following considerations:

In the general theory of bridge construction, it has been demonstrated, that when the load is uniformly distributed, the vertical strain increases uniformly from the middle to the ends. The strain upon the diagonal of any panel will be as the length of the diagonal to the length of the vertical side, and also as its distance from the middle of the truss, the maximum vertical strain being, of course, equal to the whole weight of the bridge and its load, with the momentum due to motion and vibration, when the structure is not rigid. It has also been shown that the vertical and diagonal strains upon any panel, which are always proportioned to each other in a fixed ratio, are also in proportion to the degree of angular motion, or change of figure in any panel caused by flexure; and, as the settlement of a bridge to the figure of an inverted arch would not change the rectangular slope of the middle panel, the vertical and diagonal strain upon this panel would be theoretically nothing, while at the end of the truss, the variation from a rectangular and the intensity of the vertical and diagonal strains would be greater. Knowing the whole weight of the structure, the strain upon any panel is readily determined; and it is now proposed to inquire what will be the resistance of a sheet of metal securely attached to all the sides of a rectangle, in comparison with an equal quantity of material arranged in the form of diagonal rods.



It is evident that the consideration of this question will afford the means of comparing the relative efficiency of the distribution of the material in tubular bridges, as compared with diagonal panel rods.

Let A C, in the annexed figure, represent the diagonal, which is subjected to a tensile strain, and R the resistance per unit of area, which the material is capable of opposing, A its perpendicular distance B D from the fulcrum B. The strain upon a unit at the distance X will be in proportion to this distance, and will be represented by $\frac{R}{A}X$. But as the efficiency of the resistance will be in the proportion to the leverage, which is X, the whole effect of a unit of material at the distance X, will be represented by $\frac{R}{A}X^2$, and the sum of the resistances along the line D B, obtained by the usual method of investigation, will be ½ R A² or ½ R A X A. As R represents the resistance of the material per unit of area, and (a) the number of units in the distance, BD, then Ra represents the resistance of a rod, whose area is a, and Ra × a, its moment of resistance at the distance BD. As the resistance of the triangle AGC is necessarily equal to that of ABC, the whole resistance of the rectangle ABCG will be ½ Ra2. The resistance expressed by ½ Ra2 is obtained by the use of an area of material represented by AC × a. If this same amount of material should be placed in the form of a rod in the diagonal AC, its cross section must be equal to BD or A, and its effective moment of resistance would be Ra2.

It appears, therefore, that the power of a plate to resist an angular change of figure in a rectangular frame, will be ½ as great as that of an equal quantity of material placed in the direction of a diagonal.

Where a truss is designed to support a constant weight, uniformly distributed, or, in other words, where counterbracing is unnecessary, the adoption of the tubular or plate arrangement involves an expenditure of fifty per cent. more material than would be required by diagonal rods; but where the load is variable, as is always the case in bridges, and where rods are constantly required in both diagonals, the relative economy of the two arrangements is more nearly equal, and may even be reversed. In a truss which is unsupported by an arch, a calculation of the quantities of material required in the two arrangements involves a consideration of the strains produced by the variable and constant loads in each panel. In the middle panels, the strain from the weight of the structure being theoretically nothing, the diagonals resist only the effects of the variable load, and must be equal. If the area of each rod be represented by ½ a, the two would be 4·3 a; but as the braces and counter-braces are never both in action at the same time, the plate arrangement requires a quantity of material, represented by (a), which would be equivalent to the braces and counter-braces both, and would effect a saving of material equal to ½ a. The rods in this case would require 33 per cent. more than the plate. If ½ B represents the material required in the rods of the end panels, to resist the weight of the structure, then ½ B × ½ a would be required for the main diagonal rods, and ½ a for the centre braces, making ½ b × 4 3 a. The plate arrangement would require b × a. The difference is $\frac{b\,a}{3}$ Hence, if (a) should be equal to (b), the value of the expression becomes zero; or, in other words, if the variable and constant loads are equal at the end panels, the quantity of material in the rods and plates would be the same. But if the variable load is least, there will be a loss of material by the use of the plates, which will be greater as the weight of the structure increases; and, consequently, the relative economy of the plates will be less for very long spans than for shorter. These considerations naturally lead to the substitution of sheet-iron for the rods of wooden bridges, its adoption will secure the essentially important advantages of simplicity, economy, non-combustibility, and durability. If practical difficulties do not arise from the expansion and contraction of the plates, where attached to wooden frames, as the expansion of diagonal rods is not found to be productive of any injury or inconvenience, it is possible that the slight bending or buckling which must result from the expansion of the iron plates, might not lead to any serious consequences. But whether the plan of constructing bridges by curving under frames with sheet-iron be practicable or not, the result of the calculation that has been given proves that, with a sufficient number of posts or stiffeners, the vertical plates in tubular iron bridges may be very thin, and still possess sufficient power of resistance. A tubular iron bridge, without arches, to be properly proportioned, should have the number or thickness of the top and bottom plates increased; and the side or vertical plates decreased gradually, from the ends to the middle. A tubular bridge, in which the plates are of the same dimension in the middle as at the ends, must be very badly proportioned, and contain a very large amount of useless material. If (b) represent the variable load upon a single panel or interval between two adjacent posts or stiffeners—D—the number of panels—w, the whole weight of the structure—then the proportion between the thickness of the vertical plates in the middle and at the ends, will be nearly as $v : \frac{d\ v \times w}{2}$. As this proposition may readily be as great as 1 : 5, it follows that a very great saving may be effected by proportioning the thickness of the sheets in each panel to the strains: an arrangement that appears to have been overlooked or neglected, in the construction of tubular bridges.

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Brooman's Patent Safety-Valve.

The principle of this arrangement, for effecting the objects accomplished by the ordinary safety-valve, and the construction proposed by the inventor, will be readily understood on reference to the accompanying figures.

Fig. 1 is a vertical section, and fig. 2 an end elevation of a safety-valve constructed according to the invention. A is the shell of the boiler, to which the apparatus B is riveted or otherwise secured. This apparatus is provided with two steam-ways, b, c, one of which, b, is closed by a simple valve, d, kept in place by a lever C, centered in the standard c¹, which allows it to rise, and thus let the steam free, when acted on as hereafter explained. The other steam-way, c, leads into a chamber, D, in the interior of which is fitted the corrugated spring-plate, E, which is capable of yielding under the pressure of steam against it. To the outside of the chamber D, near the top, is fixed a support, F, from which is suspended the lever G, the end of the lever being joined to the support. A rod, e, is joined to the back of the pressure-plate, E, and, passing through an aperture in the back plate of the chamber D, is joined to the lever G, at g. The lower end of the lever, G, carries an index-pointer, h, which travels in front of the scale, I, graduated to any given number of atmospheres or degrees of pressure. At the end of the scale, I, or at any other convenient part, is fastened the small upright, K, which is centered on a stud, k. A screw, L, with a milled head, passes through an aperture made in the top of the upright, K, while the bottom of the upright terminates in a catch, i, which fits into a corresponding catch, m, fitted on the long arm of the lever, C, which commands the valve d, before mentioned, for allowing the escape of the steam.

Fig. 1.

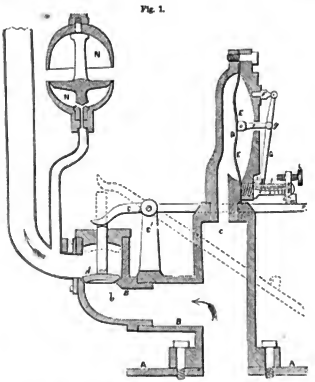
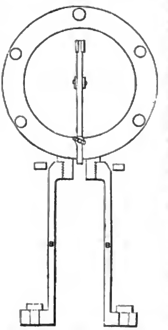


Fig. 2.



The action of the apparatus is as follows:—Supposing the parts are to be arranged so that the valve shall allow steam to escape after reaching the pressure of three atmospheres, the screw, L, is turned forward in the upright, K, until its inner end comes exactly over the figure 3 on the scale; and when the pressure shall have exceeded that of three atmospheres, the index-lever G, being pressed outwards by the pressure-plate E, and rod *e*, will press against the inner end of the screw, L, the upper end of the upright, K, will be pushed back, while its lower end will make a corresponding motion forward, and will thus disengage the catch *i*, from the catch *m*, and liberate the valve-lever, which will fall into the position shown by the dotted lines. The valve *d* being then free, will rise and allow the steam to escape. A portion of the steam will pass through the whistle N, so as to call attention to its liberation. The whole apparatus may be inclosed in a box, and locked, so that the action of the valve may not be tampered with.

The patentee also describes another arrangement, which differs from that described only in the means adopted to give motion to the lever G, for effecting the liberation of the valve *d*. In this case, the pressure-plate E, instead of being itself the spring, is a solid piston working as in a cylinder. The pressure-plate, E, is connected to the lever, G, by a rod which has a coiled spring around it, and bearing against the back of the plate, in order to bring it back to its position after having been moved by the steam which is admitted to the chamber D, by a pipe leading from the steam-way *c*. The other parts of the arrangement are the same as have been described above, and the operation of the parts is also the same.—*London Mechanics' Magazine.*

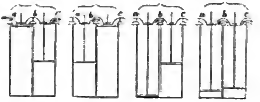
Engines and Valve Motion of the Economy.

(See Plate XI.)

The "Economy" is a steamer of an ordinary construction of American river steam-vessels, and has been running some three months in New-York harbor, plying between New-York and Coney Island. The "Economy" is 150 feet long, 24 feet wide, with about 3 feet 10 inches draught of water.

Her engines are designed with a view to obtain the fullest possible degree of expansion, with the most equable strain on the machinery, avoiding dead points. It is with some hesitation that we use the plural term in speaking of her machinery, the two being in fact but parts of one engine. Two cylinders, each 24 inches diameter and 8 feet stroke, are placed close together, one pair of side pipes serving for the two. The valves are balance puppet, 6 in number, each having a separate lifting-rod. The first pair admit steam from the boiler to the top and bottom of the starboard cylinder, the second pair open communications between the cylinders at the ends, the third are exhaust valves, opening passages between the port cylinder and the condenser. It will be observed, that the port cylinder never receives any steam from the boiler, its office being to allow space for the expansion of that which is admitted to the first, and to equalize the action throughout every point in the revolution of the wheel. This can best be understood from drawings. We deem it an essential feature in such description, that every point is made intelligible to the business man or the amateur, as well as the professed engineer; but the ordinary beam-engine being presumed to be familiar to all, a few diagrams may be sufficient to explain the principle of this novel arrangement. The whole is the invention of Mr. Daniel Barnum, of this city, who secured a patent for the same in 1846.

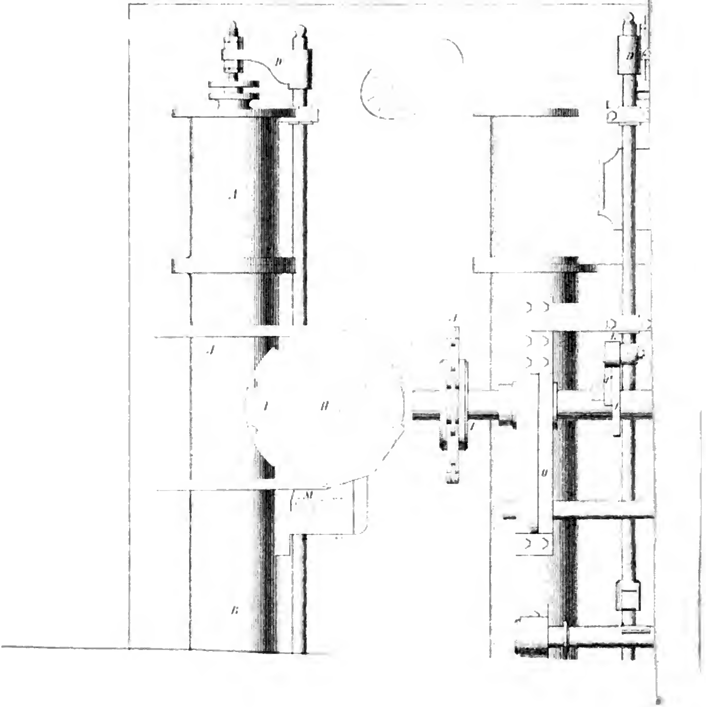
Fig. 1. Fig. 2. Fig. 3. Fig. 4.



Figs. 1, 2, 3, and 4, represent the pistons in 4 positions. As the admission of steam at the upper and lower ends of the cylinders is precisely alike, we will denote only the movements of the valves at the top of the cylinder. In Fig. 1, the starboard piston is at the top of its stroke. In this position the valve at *a* opens, admitting steam from the boiler, until it is about half stroke, the port cylinder being then on its centre. In this second position (see Fig. 2), the steam-valve shuts, and the middle or expansion-valve opens, allowing the steam to expand in both cylinders. The steam drives both cylinders down with a constant decreasing pressure, until (in Fig. 3) the starboard piston is at the end of its stroke, and its companion at half centre. Contrary to what might be expected, there is no movement of the valves [in the upper chests] at this point, one piston continuing its rapid downward movement, while the other slowly prepares to rise, and actually does rise against the pressure, until the two pistons are nearly on the same level, as in Fig. 4. At this point the exhaust valve *c* opens, and allows the steam from both cylinders to escape to the condenser. At this point it is needless to observe that the starboard piston has the full pressure of the steam on its under side, having commenced its upward stroke, in which all these operations are repeated by the valves in the lower steam and exhaust chests. The point at which the pistons would be on a level with each other, as in Fig. 4, may be readily found, by a simple construction; but our assumption that the cranks are at right angles is not strictly correct. The cranks of the "Economy" make an angle of 70, instead of 90 degrees with each other; and the position of the pistons in Fig. 4, at the moment of opening the exhaust-valve, is in reality but about 8¼ inches from the bottom of the cylinder. There is no intermediate shaft between the cranks, their close proximity to each other rendering such impracticable, and the cranks are simply connected by a drag link of proper length to hold them at an angle of 70 degrees, as observed above.

The valve motion detailed in Plate II., which is transferred from Mone's treatise, before noticed, is admirably applied to the working of the valves of this or any other engine, where it may be necessary to give balance valves any peculiar and unusual motion. It will be seen, by inspection, that the middle or expansion-valves remain open during about three-fourths of the revolution, the exhaust-valves during a little more than half, and the steam-valves only about one-fourth of the revolution of the engine. These motions are obtained by cams placed on a revolving shaft H, Plate XI., which act upon small friction-wheels L, on the lifting-rods. The shaft H receives its motion from the water-wheel shaft by an endless chain, J, of hardened steel, or case-hardened iron, acting upon a pulley I, see Figs. 1 and 2. The bearings of the shaft H are adjusted in a frame attached to the side pipes, see Fig. 3, with liberty to move vertically. The bearings are supported in their proper position for working, by the links M, Fig. 3, which links connect them with cranks wrought on the shaft N, so that when, by means of the lever P, the shaft N is turned one-fourth of the revolution, the bearings of the shaft H are so much lowered that the cams will not lift the valves from their seats. This is the method of stopping and starting the engine, a quarter revolution of the starting-bar P, in either direction, being all that is necessary. For ferry purposes, &c., where it may be necessary to revolve the wheels in the opposite direction, another set of cams may be arranged on a separate shaft, and impelled by another independent chain. The motion of the valves, by this arrangement, is very smooth and easy, and, as may be readily seen, any motion desired may be readily obtained from proper cams. Figs. 4 and 5 are side and end views of a double cam, which may be used for working the steam valves, making the cut-off readily adjustable, while the engine is in motion. A few turns of the thumb-screw 4, Fig. 4, by sliding the two parts of the cam upon each other, enables the cam to support the valve for a longer or shorter time, as may be

PLATE XI.



desired. Fig. 6 is a side and end view of the cams, 2, 2, Fig. 1, designed to hold the middle valves up during three-fourths of the stroke, and Fig. 7 presents similar views of the cams 3, 3, which actuate the exhaust valves. The trip shaft is denoted by K, Figs. 1 and 3.

For working by hand. The exhaust-valves being held permanently open by the foot-lever *a*, the starboard engines alone would act as a single engine; but by a simple but ingenious arrangement, both engines are operated by hand without difficulty. There is a single toe in the ordinary style for actuating each steam-valve; a species of double toe, the faces making an obtuse angle with each other, for raising each middle or expansion-valve, and a cam for lifting each exhaust-valve. To start the engine, the bar is inserted at S, Fig. 1, Plate II., the foot placed on the lever *a*, which raises both the exhaust-valve rods, and allows the trip-shaft to be moved endwise by hand—an operation which would otherwise be prevented by one or both of the cams R R, Fig. 1, adjusting against its respective toe on the lifting-rod. This endwise movement brings the cams under these toes, and, releasing the lever, places all the valves under the control of the starting-bar. The trip-shaft is turned but slightly at the commencement of the stroke of the starboard engine, or just enough to lift the steam, but not the middle valve; at half centre it is inclined more, and so held till the stroke is completed. A little reflection will show the effect of this on the engines in working forward; working backward with these engines is an awkward operation, in consequence of the port or expansion engine being ahead instead of behind the principal one. This must be a standing objection against the combination of engines. Backing by hand is readily effected, however, by giving proper motions to the parts already described.

The "Economy" labors under several disadvantages, one of which is a very imperfect vacuum—a fault by no means attributable to the style of engine. She is reported to perform well in accordance with her name. Her usual speed is given us at from 12 to 15 miles per hour, making 6 passages per day between Spring street and Coney Island, stopping at two intermediate points; and using from 2½ to 2¾ tons of anthracite. The distance steamed each day with this fuel is about 75 miles.

LIST OF PATENTS

Issued from the U. S. Patent Office during the month of July, 1853.

Alanson Abbe, of Boston, Mass., for Instrument for Correcting Lateral Deviations of the Spine.

Claim.—The instrument, as made, of a combination of the crutch, the hip plates, the plates, the wedges and screws thereof, the breast or body-band, and its pads, and straps or other contrivances for confining the whole instrument to the thigh and body, the whole being applied together and made to operate as specified.

A. M. Day, of Bennington, Vt., for Clavicle Adjusters.

Claim.—The arms of the yoke, hollowed as described, in combination with the straps and attached and operating as described, by means of which the acromion process of the scapula is compressed, and the arm held in position, for uniting a fracture of the clavicle, as specified.

Geo. H. Hazlewood, of Boston, Mass., for Cradle and Tête-à-Tête.

Claim.—Constructing the two sides of the bed frame of the cradle, that portions of each may be turned around and arranged parallel to one another and across the bed frame so as to convert such bed frame, into a tête-à-tête seat or chair, as specified.

C. W. Lancaster, of New Bond Street, Eng., for Cannon and other Fire-Arms. Patented in England, Jan. 16, 1851.

Claim.—First, the method of boring the barrel of a gun or other fire-arm, so that a cross section thereof would be in the form either of an ellipse or of a series of curves, by the mechanism as described, or its substantial equivalent, as set forth, whereby the injurious action of the angular groove in ordinary rifles, is obviated, while all its advantages are retained.

Secondly, I claim the construction of the boring tool for giving to the bore a form of which the cross section is not a true circle, that is to say, I claim this combination of the cutter bar with the boring tube, the said bar passing through said tube eccentrically, the axes of both being parallel, whereby the elliptical or other shaped bore, is given as described; also the bar and its inclined plane in combination with the cutter for regulating the depth of the cut, as described; also the expanding collar, the inclined or bevelled space, on the boring tube, with the other parts in connection therewith, as described, for the purpose of guiding the boring-tool when boring out an irregularly formed cylinder, as described.

Third, I claim the curved rail, or other like fixture for giving the proper motion to the barrel of the gun during the boring operation, by which the spiral or twist is given, as described.

Fourth, I claim the cap for supporting the boring tube just at the moment the cutter is about to clear the muzzle, as set forth.

T. L. Mitchell, of Birkenhead, Eng., for Propelling Vessels. Patented in England, Nov. 25, 1848.

Claim.—Constructing the blade or blades of the same upon the principle or in the form of the "bommareng," as described.

John North, of Middletown, Conn., for Trusses.

Claim.—As my improvement in trusses and supporters, the mode set forth of adjusting the pressure of the pad, that is to say, by the employment of the right and left screw, and the adjusting nut in combination with the pad lever in the manner set forth.

Wm. Porter & E. A. Tuttle, of Williamsburgh, N. Y., for Lanterns.

Claim.—The small rods extending from the lower part or cup of the lantern to the top or cap, and uniting them both together by a catch, thereby securing the globe between them in the manner set forth.

Amzi C. Semple, of Cincinnati, Ohio, for Paddles for Vessels.

Claim.—The use of vulcanized India-rubber or other similarly elastic substance which will produce the intended effect in the construction of floats of paddle wheels for the purpose described.

N. J. Tilghman, of Salisbury, Md., for Crow Killers.

Claim.—The combination of the dart, helical spring, sliding rest, or head, attached to the triggers and the dog, with the hollow post in which it is placed.

J. Cross, of New London, Ohio, for Improvement in Brushes.

Claim.—A brush consisting of a divided case to hold the handle and bristles, constructed and arranged as described, in combination with a wedge forced among the ends of the bristles within the case and tightened from time to time, so as to squeeze and hold them, by screwing the two parts of the case together, as specified.

E. H. Ashcroft, of Boston, Mass., for Pressure Gauges.

Claim.—The method of rendering the indications of bent tube pressure gauges permanent and reliable, by constructing said tubes of precious metal, as set forth.

C. W. Camp, of Hartford, Conn., for Shot Charges.

Claim.—The method of making and the application of the revolving cut-off and spring to shot charges, as described.

E. J. Dickey, of Hopewell Cottonworks, Pa., for Butter Workers.

Claim.—The adjustable knives arranged within the box of said machine, and operating in conjunction with the reciprocating pressure, substantially in the manner set forth.

I also claim the recess or depression in the bottom of the box for the purpose of preventing the butter adhering to the presser, and being drawn back during its receding motion, as described.

G. M. Dimmock, of Springfield, Mass., for Apparatus for Illustrating the Motion of a Pendulum upon the Earth's Surface.

Claim.—The application to an artificial globe of one or more pendulums, the rods of which are formed of delicate springs so as to vibrate evenly to all points of the dial, the plane of which is at right angles to the pendulum when at rest.

I also claim the bending or springing the pendulum rods, to counteract the gravity of the earth, so that when at rest they will be straight and on the line from the point of suspension, and the centre of the globe; furthermore, I claim any thing substantially the same.

J. J. Fulton, of Alleghany City, Pa., for Tanning.

Claim.—The use of muriate ammonia, in combination with nitre, for the purpose of suspending putrefaction, adding strength to the animal tissues, and for usual purposes in the manufacture of leather, as set forth.

Smith Groom, of Troy, N. Y., for Hose Coupling.

Claim.—The spring conduit and the appendages by which it is moved longitudinally, and is held firmly against the packing and the pads or rim in which the packing rests, to prevent the joint from leaking, in combination with the arrangement of spring bolts and their appendages, as shown, with the circular groove, as set forth.

Richard Montgomery (assignor to Elizabeth Montgomery), of New York City, for Sheet Metal Beams. Patented in England, Oct. 18, 1852.

Claim.—A beam formed of sheet metal bent into a series of longitudinal folds, the sides of which are flat and parallel, and the tops and bottoms uninverted and inverted arches respectively.

I also claim the combination with such a beam of a pair of saddles to support its ends, as set forth.

Myer Phineas, of New York City, for Metallic Pens.

Claim.—Constructing the back of the pen with a series of transverse ribs and slots, and leaving two flat springs beneath, nearly parallel to the back and free to bend between the ribs; the effect of this construction being to give to the pen combined stiffness and flexibility within certain limits, resembling that produced by a series of vertebral articulations, and which is found to render the working of the pen more easy and pleasant than any form of metallic pens heretofore essayed.

H. G. Robinson, of Schuylkill Haven, Pa., for Coin Safe and Detector.

Claim.—The peculiar construction of the implement, and the manner in which the several parts are arranged, by which construction and arrangement I combine a portable receptacle for both coin and bank notes, convenient for the pocket, and a counterfeit coin detector. The implement being formed of a cylindrical case, having a guage box or receptacle at one end, and the remaining portion of the case inclosing the clamps, for the purpose shown, and otherwise constructed as set forth.

S. T. Sanford, of Fall River, Mass., for Boring Machines.

Claim.—Fitting the auger stock by a ball and socket, or other universal joint to an arm, which is connected with a fixed base or standard, so as to be capable of moving in arcs, at any angle to each other, and giving rotary motion to the auger so arranged, by means of a pulley attached to the auger, and a band receiving motion from a pulley on a shaft, at the butt end of the pole or arm, as described.

E. B. Wells, of Uniontown, Pa., for Adjusting Dishing Saws.

Claim.—The adjustable rings in combination with the concave and convex washers, as described, for the purpose of holding and regulating the saw to any required curvature.

I. P. Smith, of Rochester, N. Y., and O. W. Seely (assignor to O. W. Seely), of Albany, N. Y., for Straw Cutters.

Claim.—The arrangement of the metallic guide in combination with the knife frame, and the knife formed as specified, and with the frame against whose front edge the knife is intended to play, the last-mentioned frame to be adjusted to its place by springs and screws, contained in hollow boxes or ears, and by trunnions and shoulders, as set forth.

N. T. Coffin, of Knightstown, Ind., for Forming Teeth on Mill Saws.

Claim.—The dies and gauge constructed as described, by means of which uniform chisel points are given to saw teeth by swedging, as specified.

Also the combination of the two files, the block, turned surface, and regulating screw, forming together the file gauge, by means of which, when used in combination with the bevelled file, the chisel-pointed saw teeth described, are dressed, jointed, and have their edges rendered uniform, as specified.

Chas. F. Brown, of Warren, R. I., for Adjustable Screw Propellers.

Claim.—First, arranging the pivots of the adjustable blades, out of the centre of the hub, or at a distance from the axis, and carrying them right through the hub, as described, whereby they obtain a greater depth of bearing, without placing one blade behind the other, and thereby rendering it necessary to cut away and weaken the after part of the vessel unnecessarily; this I claim without reference to precise means by which I turn the said pivots to adjust the blades.

Second, the employment of one of the adjustable blades of the screw propeller or a rudder, in case of need, when the said blade is operated for this purpose by mechanism, such as described, which also serves to adjust the blades as a propeller.

Linus Yale, Jr., of Newport, N. Y., for Locks for Banks.

Claim.—Impressing the form of the key upon inert tumblers or their equivalents, which shall retain said impression, which, being separated from the key, and beyond reach or influence through the key-hole before they can touch the fence, as described.

I also claim, in combination with the inert tumblers, the cross bolt which takes the strain of end pressure on the main bolt, and acting as a tumbler carriage to convey the tumblers beyond reach or influence through the key-hole when it moves them to the fence out of its locked position with the main bolt.

C. P. Bailey, of Muskingum, Ohio (assignor to "Union Patent Sofa and Railroad Car Seat Manufacturing Company," of New York City), for Railroad Car Seats.

Claim.—So hanging a reversible car-seat, whose seat when reversed forms a portion of the back, and vice versa, as that it shall occupy the same space after it is reversed that it did before, or hang between, or nearly so, the same parallel lines that it did before reversing, and so that also the seat and back may have an adjustment together or independent of each other, as described, and this I claim, whether the seat is divided into two or more parts, or used without division, as set forth.

S. T. Barnes, of Columbus, Ohio, for Press Mould Candlesticks.

Claim.—The wick tube to guide and retain the wick in the centre of the candle, in combination with the wick, so arranged on a spool as to supply a continuous wick, as the tallow is forced out to form the candle, as described.

J. C. Booth, of Philadelphia, Pa., for Processes for Obtaining Chromates. Patented in England, Nov. 9, 1852.

Claim.—I do not desire to claim separately such portion of the process described, as I have stated to be similar to that now in use for manufacturing chromate and bichromate of potash.

But I claim, first, the reduction of chrome ore by the carbonaceous materials, as described, as a stage in the manufacture of potash.

Second, the art or process of manufacturing chromate and bichromate of potash from chromic iron ore, by means of the reduction of the oxide of iron, and the removal of the reduced iron by the several substances and modes set forth.

Third, I claim the process of reduction and removal described, in connection with the process of reduction described, or in combination with the equivalent therefor.

A. H. Brown, of Washington City, D. C., for Feathering Paddle Wheels for Steamers. Patented in England March 5, 1853.

Claim.—The combination of the pinion, rack cam, and steering drum, with the eccentric, for the purpose of adjusting the paddles and converting them into a powerful steering apparatus.

I also claim the combination of the curved paddle with any apparatus for adjusting and feathering the same.

Isaac Brown, of Baltimore, Md., for Driving Saws.

Claim.—The mode described of applying the power of the engine to the saw gate or frame, without being permanently connected therewith, so that the piston shall, in a great measure, be relieved from any lateral motion which the gate may have, which causes it to bind or cut in the cylinders, as described.

N. T. Coffin, of Knightstown, Ind., for Hanging Saws.

Claim.—The combination of the stirrup hung upon a knife edge, with the adjusting screws, for the purpose of regulating the rake of the saw in the manner described.

C. J. Conway, of New York City, for Lamps.

Claim.—I do not claim the peculiar property of small tubes preventing the passage of flame; neither do I claim the making the base of the lamp serve as a reservoir for the fluid used. Nor do I claim the construction by which no part is made movable, but the cap of the feeding tube.

But I do claim that peculiar construction by which two chambers or reservoirs are combined in the same lamp, one containing the wicks and the fluid which saturates them, and the other forming the receptacle into which the fluid is poured, and the two chambers communicating by means of two pipes or tubes, the whole arranged and operating as described, by which means the wick chamber is filled, and may at any time be replenished from the larger reservoir by simply changing the position of the lamp from a vertical to a horizontal direction; and the larger reservoir may be supplied without bringing the can or filler near the burners.

John Jackson, of Lawrence, Mass., for Spinning Jacks.

Claim.—I do not claim stripping the bobbins preparatory to winding on. Neither do I claim raising the "former" by a horizontal screw, giving motion to an inclined plane beneath it.

But I claim the stop, in combination with the tappet or gear, for the purpose of arresting the motion of the latter at the instant the belt is shipped upon the pulley, that the gear may be left in the precise position necessary for the performance of another duty, the instant it is again set in motion, without being carried past this position by momentum or otherwise, when the brake is so arranged in connection with the lever, or otherwise, that it shall be withdrawn by the mechanism which shifts the belt at the instant the gear is again set in motion, the operating the winding on mechanism, raising the stripping wire, and depressing the building wire, in the proper order, and then shifting the belt on to the fast pulley at the close of these operations, by means of a single cogged gear in combination with the tappet placed upon its side, the whole arranged as set forth.

Edmund Munson, of Utica, N. Y., for Eyes for Mill Stones.

Claim.—I do not claim the conical form of a portion of the eye; nor do I claim a metallic eye; but I claim the spiral wings arranged in such manner as to perform the double office of feeding the grain and supporting the stone.

R. C. Pratt, of Canandaigua, N. Y., for Machines for Ditching.

Claim.—The ditching machine, consisting of a beam and casing, or their equivalents, in one or more parts, with a cutting and scraping point, hung on the shaft of a revolving wheel, with shovels attached to the outer circle of the wheel, which self-act by turning the wheel and forming a bucket in connection with the casing, so as to carry up the earth to the inclined slides, the whole being operated as described.

John Farrel, of Philadelphia, Pa., for Lining for Fire-proof Safes.

Claim.—The application and use of flour, grain, maize, starch, or other vegetable substance of a like nature, either alone or in combination with lime, cement, or similar substances, in the construction of fire-proof chests or safes, as described.

Bradford Rowe, of Albany, N. Y., for Gripes for Holding Leather.

Claim.—The construction of a gripe composed of a key within a socket or chamber, the key being a solid cylinder, with a portion of its surface cut away, in two faces parallel with its axis, and at an angle with each other, one face being grooved lengthwise, and the chamber being a hollow cylinder, with a portion of its space filled up parallel with its axis, and having a longitudinal slit through it for nearly its whole length, corresponding with the cut away part of the key, so that when the key is in the chamber a strap of leather or other material can pass through the chamber and under the key, as described.

Geo. B. Salmon, of Elmira, N. Y., for Grain Winnowers. Ante-dated July 6, 1853.

Claim.—I do not claim the blast head or the blast spout separately; neither do I claim the screen nor the trough and spouts separately.

But I claim, first, the expansion of the upper part of the blast spout, into the circular irregular enlarged head with an opening or mouth at the lower extremity, partly covered with the sieve, for the purpose of allowing the force of the blast to be exhausted, the screenings immediately falling through the opening or mouth of the head, while the blast and dust escape through the screen, the blast being governed by a slide, as set forth.

Second, I claim the arrangement and construction of the graduated sieve of unequal fineness, the portion being protected from the action of the fan blast, so that the small substances, such as cockle, &c., passing through and falling on the bottom board of the sieve, passing off at the trough and spouts, and when the grain arrives at the coarser part of the sieve, it passes through and is acted upon by the fan blast, while larger substances than wheat pass over the end of the sieve, and fall on the floor, as set forth.

Ephraim Treadwell, of New York City, for Ovens.

Claim.—The use of a perpetual oven having side doors in it, for charging and discharging it at intermediate points between the ends of the oven, in combination with upper and lower independent heating flues and furnaces, for directing the entire heat from one set of furnaces through flues on the upper side of the article to be baked, and the entire heat from the other independent set of furnaces through flues on the under side of the article to be baked, as set forth.

Wm. H. Thompson & Wm. H. Plummer, of Biddeford, Me., for Compressers for Flyers.

Claim.—The combination of the guard rib with the hole and the passage, and the opening, for the purpose specified.

P. P. Travser, of Baltimore, Md., for Spike Machines.

Claim.—The combination with the knife which severs the blank from the rod, of two stumps either or both moving, whereby, while one blank is being headed and pointed in the dies, the end of the rod for the next blank is cut off and bent preparatory to forming a head, as described.

I also claim the method of heading spikes by bending the end of the rod preparatory to upsetting, before placing it in contact with the heading dies, instead of giving it the preparatory bending while in contact with the dies, whereby the heated rod is kept a shorter time in contact with the dies, and therefore heats them less, while at the same time it is not detained longer than usual out of the dies, so that by this method the dies are better protected from excessive heating, the rod from cooling, and the whole operation expedited and improved, as set forth.

S. J. Sherman, of New York City, for Mounting Spirit Levels.

Claim.—The spring catch to hold the level in place upon the square or ruler, in combination with the bearers, the latter being so formed in respect to the level, that when they are placed upon a horizontal line, the bubble will be in the middle of the glass, and thus a horizontal or a vertical line may be ascertained from a ruler or from a square, when said level is attached as set forth.

T. C. Weildon, of Hartford, Conn., for Manufacture of Wigs.

Claim.—The method of fastening and attaching the hair to wigs, toupees, or any other kind of hair work, by means of any kind of glutinous substance, as set forth.

Chas. Williams, of Philadelphia, Pa., for Bristles for Brushes.

Claim.—In the manufacture of that class of brushes known as "drove-work," preparing the bristles by the application of heat to the roots, as set forth.

Leonardo Westbrook, of New York City, for Gutta Percha Stereotype Compositions.

Claim.—An improvement on the patent of Josiah Warren, dated April 25, 1846, first, the compound described, of shellac, plumbago or graphite, asphaltum and gutta percha, treated by sulphate of copper and water, as described, as a substitute for type metal.

A. O. Wilcox, of Philadelphia, Pa., for Caloric Air Engines.

Claim.—The interchanging circulators situated within and occupying one half of the capacity of each heat reversing vessel, and so arranged as to alternately transfer the air or other fluid to the heating and cooling divisions of said vessels in the same movement to cause the air to pass through renovating plates or their equivalent, whether placed within the circulators and transmitting the air, or placed without the circulators and the air forced through them, as described.

I also claim placing an inwardly pressing packing in the open end of each working cylinder, and in combination therewith the construction of the working piston (being of the requisite length) of a little less diameter than the interior of the cylinders, whereby the friction surface is confined to the periphery of the piston, in order to sufficiently exclude its lubricating fluid from the contact of the hot-air within the cylinders, as set forth.

I claim the barrel and stationary hollow piston, with its supply tube, aperture, valves, in combination with the working piston and its valves, for the purpose of supplying air or other fluid to the cylinders, when desired, as described.

Frederick Hesse (assignor to H. J. Oerter), of Bethlehem, Pa., for Paper Cutting Machine.

Claim.—I do not claim a stock provided with a knife or cutter, working on a bed-piece, irrespective of the employment and arrangement of the rack bar and pinion, as that has been previously used.

But I claim cutting paper, pasteboard, or other articles, by means of a knife or cutter, attached to a rack bar, which meshes into a pinion, said pinion being hung or attached to a spindle or shaft, to the ends of which the handles of the sliding stock are secured, the above parts being attached to the sliding stock, by which device the knife or cutter may be elevated or depressed, as desired, while working the sliding stock upon the bed piece, as set forth.

Cyrus C. Bishee, of Rochester, N. Y., for Shower Bath Tables.

Claim.—The combination of the upper and lower tray as described, so that they shall simultaneously recede from each other to elevate the water and set up the bath, and approach each other to pack away the bath and convert the apparatus into a table.

R. C. Bristol, of Chicago, Ill., for Rotary Steam Engines.

Claim.—The combination and arrangement of the outward radiating pistons or their equivalents, with their sliders, steam-ways, or passages and abutments, in such manner that the sliders are free from lateral friction by pressure of the propelling medium in passing the abutments, and are worked outwards and kept up to their bearing by the pistons, as specified, whereby promptness and certainty is insured in the outward action of the sliders, counteracting pressure to their inward radiation removed, and a tight but free action of the sliders through their entire travel, produced as set forth.

Wm. V. Burton, of Orange, Ohio, for Plows.

Claim.—The manner of securing the points of the land side, land cutter, and counter side, by the lock couplings or joint formed in the mortise by the curvature of the land cutter, as set forth.

Second, I claim the plow-point, and a reversible land-side piece, in the manner specified, whereby the land side piece and point is made reversible.

F. B. Hunt, of Westfield, Ind., for Mills for Grinding Apples.

Claim.—I do not claim the employment of the endless belts, irrespective of their arrangement, as they have been long used; neither do I claim the cutters nor cylinder press separately.

But I claim, first, the employment or use of the endless belts, arranged as described, viz., the upper belt, having an adjustable roller, which, upon being elevated or depressed, causes the belts at the discharge ends to be brought nearer together or separated further apart, thus allowing the belts to be adjusted to feed or convey to the cutter all the different articles or substances which at present require each a separate and distinct machine.

Second, I claim, in combination with the two endless belts arranged as described, one or more cutters or cutting cylinders, said cylinders being placed loosely on their axes, and secured by set screws, as described, by which several forms of cutters may be used, according to the work required to be performed.

D. A. James, of Cincinnati, Ohio, for Processes for Making Glue.

Claim.—First, the method described, of the preservation and conversion into glue of the tanner's scraps, &c., by open piling successive layers of scrap coated by cream of lime (in place of the lime steeping heretofore resorted to) followed by the application of sulphuric or other suitable acid, which, combining with the lime, prevents its deleterious action on the glue, and supersedes the necessity of the atmospheric exposure now resorted to.

Second, the combination with the said previous treatment the process, as described, of making glue by means of the combination of direct or indirect steam, acting in concert or separately, according to the stage of the process and the relative heat and moisture required, avoiding on the one hand the injurious scorching effects of the open furnace, and on the other hand the serious inconvenience of undue dilution by the open steam jet.

Owen Redmond, of Rochester, N. Y., for Lamps.

Claim.—Resting the oil fountain upon a spring or springs, so constructed as to retain the surface of the oil in the fountain constantly at or nearly uniform height, and this I claim whether used with or without a float, as set forth.

Milton Satterlié, of Louisa, Ill., for Seed Planters.

Claim.—The arrangement of the drill and covering wheels, or their equivalents, on flexible axles, so that the said wheels or their substitute will rise and fall to accommodate themselves to undulating ground, whereby the grain in all the furrows is planted at an equal depth and equally covered, as specified.

Wm. M. Warren, of Watertown, Ct., for Railroad Car Seats.

Claim.—I do not claim a rotating seat.

I claim attaching the hinged or adjustable back to the stationary back, by means of the hinges, and having a jointed or metal strip secured to the adjustable back and to the cross-piece, the hinge or joint of the metal strip being above the line of the hinges, by which arrangement the seat is inclined or brought to a horizontal position, as the adjustable back is raised or depressed, as described.

Ezra R. Benton, of Milwaukie, Wis., for Bran Dusters.

Claim.—A bran duster, patented Feb. 27, 1849, having a fan with oblique wings, is employed at the top of the machine for producing a draught of air into the same, and a fan with wings parallel with the axis of the cylinder, is employed at the bottom of the machine into a lateral opening in the side of the same. This I do not claim.

I do claim the combination of the two inwardly acting draughts of air of different degrees of strength produced by the oblique fans, when their forces are proportioned in such a manner that the upper blast will feed the bran into the machine and drive the flour through the sieve, while the lower current only counteracts the downward pressure of the upper blast, so as to prevent any flour falling to and being discharged with the bran at the aperture in the bottom of the duster, as described.

Jacob H. Carothers, of Davidsburgh, Pa., for Corn Planters.

Claim.—The method of stopping the seeding apparatus by grappling the periphery of the driving wheel, as described.

Sylvester Davis, of Claremont, N. H., for Bee Hives.

Claim.—The manner of constructing the float of two parallel series of lightly separated thin slats placed one directly over the other, and separated by two or three cross slats, and supported by similar cross slats beneath the whole, for the purpose of allowing the bees to feed without being liable to be mired in the food beneath.

Ziba Durkee, of Alden, N. Y., for Smut Machines.

Claim.—The covering of the revolving cylinder, wings, or beaters of smut machines with wire netting or cloth, for the purpose of providing an uneven but smooth beating or rubbing surface, and at the same time give great durability to the said parts, as described.

F. O. Deschamps, of Philadelphia, Ohio, for Omnibus Lanterns.

Claim.—Constructing the case of the lamp, in the manner described, viz., the lower part of the case being constructed of glass, and the upper part of the metal, having a lens inserted in it, by which construction the lamp, when placed as shown, is made to illuminate the interior of the omnibus or stage, and also to afford light on the top or roof of the omnibus or stage to enable the driver to see distinctly what money or ticket he may receive, and to facilitate him in giving change.

J. A. Elder, of Westbrook, Me., for Covering the Backs of Books.

Claim.—First, hanging the frame, carrying the pressure roller upon and eccentrically to the centre of motion of the arms, so that the centre of motion of the frame can be raised at pleasure, as described.

Second, the combination of the wedge and bars, when connected with the jaws of the clamps, as described, for the purpose of keeping the centre of the book, whatever its thickness, vertical with the bearings of the swinging frame, as described.

D. B. Hinman, of Philadelphia, Pa., for Dyeing Yarn Parti-colored.

Claim.—The employment of a series of separate and adjustable or changeable bars, one above the other, in an adjustable press, and pressing between their faces the parts of the yarn not intended to be dyed while the liquor is in contact with them, and dyes the parts of the yarn between the sides of the bars, as described.

Levi Pitnam, of Tonisbrook, Va., for Plotting Theodolite.

Claim.—The adjustable index, or its equivalent, in combination with the graduated scale upon the traversing ruler and the horizontal dial, as described.

I do not claim a rotating draughting board turning upon a fixed centre-pin in a protracting arch with a traversing ruler working upon two graduated parallel guide strips. But I claim a dial fixed upon a staff or socket, in combination with the revolving frame, turning under said dial on the socket, and carrying the traversing ruler, and a suitable sight vane constructed and operating as described.

J. A. Rapp & E. S. Wright, of Buffalo, N. Y., for Straining Saws by Compressed Air.

Claim.—The application of compressed air to the straining cylinders of saws, when said cylinders are so connected with each other that the compressed air shall alternately pass from one cylinder to the other during the reciprocating action of the saw, and combined with the air pump and pressure valve, for the purpose of regulating and maintaining the intensity of the steam on the saw, as described.

F. G. Vettereke, of New York, N. Y., for Dyeing Compounds.

Claim.—The making of the alkali compound, substantially as set forth, as a basis for a blue dye.

H. L. Novis (assignor to S. T. Armstrong), of New-York City, for Preserving India Rubber in the Liquid State. Patented in England, Feb. 24, 1853; and in France, March 13, 1853.

Claim.—The compound, consisting of the native juice of the caoutchouc, with aqua ammonia, or the equivalent thereof, as set forth, when said ammonia or its equivalent is mixed with said juice of the caoutchouc in a liquid state, by means of which the juice above-named is preserved for a great length of time, and can be manufactured at less expense than the India rubber of commerce, which is mixed with other foreign substances.

And I also claim the solid elastic article when manufactured from the said composition of matter, as described.

RE-ISSUES.

D. P. Bonnell, of Tecumseh, Mich., for Process of Flouring. Patented originally Aug. 14, 1849.

Claim.—The process of grinding the offal of grain, immediately after it has passed from the bolts, contemporaneous with the first flouring, and by the continuous operation of the machinery adapted to said process, as set forth, for the purpose of increasing the quantity and improving the quality of the superfine, or other flour.

Leonardo Westbrook, of New York City (assignor to Josiah Warren, of Posey, Ind.), for Composition for Stereotype Plates. Patented, April 25, 1846.

Claim.—First, the mixture, as described, of shellac, tar, and sand, as a substitute for type metal.

Second, I claim the use of shellac, as a basis to form a substitute for type metal, when it is mixed with the substances I have mentioned, or with other substances of a similar nature.

Third, I claim also the use of clay, mixed with sand in various proportions; also with gum arabic, beeswax, stearine, tallow, and wax, as described for the purpose of engraving or forming matrices or moulds in which to make casts for typographical purposes, of the material and in the manner as set forth.

Fourth, I claim, also, the use of clay as a basis from which to form matrices or moulds, as aforesaid, whether it be mixed with the materials I have mentioned, or whether other substances be used instead of them, but of the same nature.

Fifth, I claim, in combination with the employment of plastic material for stereotyping, the employment of the bearers in the manner described, for the purpose of obtaining casts exactly level, and of type height.

J. A. Bazin, of Canton, Mass., for Reed Musical Instruments.

Claim.—In the construction of organs, reed, and other similar instruments of music, first, flatting the thirds, sixths, and sevenths of the scale by means of the regulating cylinder, constructed as described, or by any other analogous contrivance, as set forth.

Second, the valve, constructed, as described, of the two parts, with the two springs or their equivalents, in combination with the perforated plate, for the purpose of sounding the note flat or sharp, as set forth.

Third, the combination and arrangement of the sliding bar, the buttons, the bent wires, by which means the key board may be unlocked and moved in either direction by one hand, as set forth.

Fourth, I claim the use of two or more wind-chests in the same instruments, for the purpose of providing a separate supply of air for the bass and treble notes, as set forth.

Fifth, the peculiar arrangement of the bellows and wind-chests, the latter being placed below the former, and communicating with the reed box by means of flexible passages passing up through the bellows, as described which arrangement of parts enables me to make use of two wind-chests, as set forth.

Sixth, having the pedal with a movable fulcrum to prevent friction upon the foot, and to enable it to be operated with more ease and convenience, as set forth.

Seventh, the construction and arrangement of the air passages above and below the reed as described, for the purpose of admitting the air, and permitting it to escape at the butt end of the reed, as set forth.

Eighth, the presser bar, so constructed and arranged, as to keep down the rear portion of all the valves, while their front portion is left free to be operated by the keys, thereby modifying the tone of all the notes of the instrument, as set forth.

G. W. Brown, of Tylerville, Ill., ante-dated February 2, 1853, for Seed-Planters.

Claim.—First, the oscillating horizontal wheels, or distributors, in the bottom of the hoppers, having slots and holes of various sizes, in combination with the stationary caps and pins for the discharge of different kinds and quantities of seeds, as set forth.

Second, I also claim the arrangement of the covering rollers, mounted as described, and performing the purpose of covering the seed, elevating the cutters, in turning around, and also in adjusting them to different depths, as set forth.

Lebbens Caswell, of Harrison, Me., for Seed-Planters.

Claim.—Placing the axle of the gauge wheels on a fulcrum, in an adjustable slide, as described, so as to plant at any desired, and at the same time a uniform depth, as set forth.

S. R. Cline, of Philadelphia, Pa., for Water Regulator for Steam-Boilers.

Claim.—The water-chambers described, and the contrivance and machinery, by which their action is aided and facilitated.

H. B. Conant, of Geneva, Wis., for Abdominal Supporters.

Claim.—Constructing the supporter with two encompassing springs, attached respectively at their centres to the front and hind pads (the hind spring being slightly curved upwards in the middle, and the front spring correspondingly curved downward, and both springs straight on their flat sides, as described, and uniting said springs at their adjacent ends, with straps of adjustable lengths, whereby its pressure may be varied at pleasure, and the same supporter worn by persons of different sizes, as set forth.

T. J. Eddy, of Waterford, N. Y., for Railroad Car Wheels.

Claim.—A cast-iron car-wheel made in one piece, in which one end of the hub is united to the rim by means of a disc, and the other by means of a series of spokes, as set forth.

C. S. Boynton, of New York City, for Paper-Ruling Machine.

Claim.—First, the employment or use of the guides, by which the paper may be properly adjusted upon the apron, and fed underneath the pens.

Second, I claim the guides or stops attached to the selvedge of the endless apron, for the purpose of elevating the pens from the paper, at required distances, according as the guides or stops are adjusted upon the apron, and thereby causing the paper to be ruled in lines of the desired length, and having the requisite spaces between them, as described.

J. R. Miller, of Jersey City, N. J., for Submarine Tunnels.

Claim.—Constructing submarine avenues by casting them in short manageable sections, sinking each successively to its place, and uniting their ends successively, by means of flanches, bolts and packing, as described, when these are combined with a lip or lips, at the end of each section, to insure the bolt holes, and other corresponding parts to come and rest opposite to each other, as each succeeding section is sunk to its place; and when the structure is made to rest upon a graded bottom, as the work progresses, and is held thereto by superincumbent weight, when completed. I do not claim any one, or any number of the elements specified, except in combination with all the others; nor when used for any other purpose than that specified.

J. A. Scholfield, of Westerley, R. I., for Temples for Looms.

Claim.—The application of a stationary spur plate, to the temple, with the pins in said plate inclined at an angle to the breast-beam, so as to allow the cloth to be drawn down over the tops of said pins, as the lay beats up, and from their inclination, preventing the cloth from receding, during the backward motion of the lay, as described.

John M. Reeder, of Memphis, Tenn., for Steam-Boilers.

Claim.—The application to steam-boilers of a stem and the two valves, and the mode of their operation, which will, at any given pressure, allow the water in the boilers to pass freely on the fire underneath them, thereby retaining the steam and prevent explosion, as described.

J. R. Richardson, Jas. Waterman, and Ebenezer Wilder, of New Castle, Pa., for Machines for making Spikes.

Claim.—First, the manner of forming the point of the spike, as described, viz., by means of the combination of the wide dies, resting on the discs of the rollers, and the pointing rollers, arranged as set forth.

Second, we claim slightly withdrawing the header, after the head is completed, for the purpose of relieving the jaws from its pressure, before they begin to open, and holding it in that position, with the spike head therein, until the jaws are opened, and the movable jaw and die are nearly or quite withdrawn from the spike, then withdrawing the header to its farthest position from the dies, allowing the spike to fall, thus causing the header to perform the duty of a clearer, as described.

Third, we claim the combination of the cutting guide loop, the cutter and the holder, as constructed and operating with the movable jaw and movable die, for the purpose of cutting off the blank at sufficient distance from the ends of the dies to leave material for the head, and carrying it over to the stationary jaw, at the same operation, as described.

Fourth, we also claim attaching the gauge firmly to the carriage of the pointing rollers, so that it will be withdrawn as the point is drawn out by the rollers, and returned to its position, when the pointers are withdrawn without any other mechanism to actuate it, as described.

I. S. Richardson, of Boston, Mass., for Atmospheric Telegraph and Railway. Patented in England, Dec. 7, 1852.

Claim.—First, the check plate, consisting of three pieces, two being stationary, and the third or middle one, revolving between them, air tight, constructed as described, or in any manner substantially the same, and for the purposes set forth.

Second, the turn-table constructed as described, of the ring and its station box, in combination with the two rings, or their equivalents, as set forth.

Third, the method of announcing the arrival of the plunger, by means of the compression of the air within the cylinder at the instant of the arrival of the plunger, operating through the orifice in the cylinder, the valve, and the hammer, as described, or in any other manner equivalent thereto, the compressed air being the agent.

Fourth, I claim the combination of the pendent lever with the valve and spring, or analogous devices, by which means the valve is drawn up to its seat, when no longer kept open by the pressure of the atmosphere, and firmly locked in that position, until the lever is again tripped by the passing plunger or load.

S. P. Ruggles, of Boston, Mass., ante-dated Feb. 2, 1853, for Printing Presses.

Claim.—The combination of the adjustable gauge with the diverging springs for catching and guiding the edge of the sheet when it is sliding to its position, as described.

Nathan Thompson, Jr., of Williamsburgh, N. Y., for Indicating the Height of Water in Steam-Boilers.

Claim.—I do not claim either floats or valves, or chambers or levers as my invention, nor the combination of a float within a boiler, with indicators or alarms.

I claim the method, as described, of slowing and stopping the main engine by means of a float, or its equivalent, which is governed in its position by the height of the water in the boiler, whereby I am enabled to furnish a reliable and not to be disregarded intimation of the level of the water in the boiler.

Secondly, I claim a hook and pin, or their equivalents, in combination with a boiler float, whereby said float is prevented from acting during ordinary fluctuations of the water level, as specified.

Wm. Van Anden, of Poughkeepsie, N. Y., for Machinery for making Railroad Chairs.

Claim.—The combination of rollers with adjustable shear stocks for cutting and shaping the lips of wrought-iron railroad chairs, as set forth, and their combination with the dies for that purpose.

I also claim the use of a movable drop, upper half or female die, in combination with a stock, as set forth, and their combination with the discharging apparatus, operated as set forth.

I also claim the use of adjustable and removable benders, in bender stocks, in combination with the levers and cams on the main shaft, for operating the same in an oblique and downward direction, and their combination with the dies and cutters for making wrought-iron railroad chairs.

Stephen Waterman, of Williamsburgh, N. Y., for Obviating the Danger from Steam-Boiler Explosions.

Claim.—I do not confine myself to placing the cold water reservoir on the top of the safety-chamber, as it may be placed in other positions, and instead of communicating with the safety-chamber, may communicate with the steam space of the boiler; nor do I confine myself to the particular mechanical means by which the tearing apart of the safety plate is made to open the communications between the water reservoir and the boiler, and safety chamber.

But I claim the combination with the safety-chamber and safety plate of a cold water reservoir, which has means of communication at the lower part with the safety chamber or steam space in the boiler, and at the upper part with the steam space in the boiler, which said means of communication are closed when the boiler is in proper operation, by cocks, or their equivalents, which are caused to open by the tearing apart of the safety plate in any manner as described, for producing the effect set forth.

Jesse Young, of Franklin Furnace, Ohio, for Arrangement of Pipes for Hot Blast Furnaces.

Claim.—The arrangement of a series of angular horizontal pipes, three short vertical connecting pipes, which also serve as supports or pedestals, and a hollow base, through which the cold air passes into the pipes, and upon which hollow base the pipes rest, by which arrangement the air is made to pass slowly through the pipes and base, and is exposed a sufficient length of time to the action of the heat to become heated with a small expenditure of fuel.

J. T. Coupier & M. A. C. Mellier, of Paris, France, for Manufacture of Paper Stuff. Patented in France, May 7, 1851.

Claim.—We do not claim the use of alkalies in the treatment of vegetable fibre for the preparation of paper pulp; nor do we claim the individual parts of the apparatus employed in our process.

But we claim first the process described, of reducing straw and other similar vegetable matters into pulp for making paper, said process consisting in applying and circulating the solution of the hydrate of soda or potash in the manner described, and at or about the strength indicated, in combination with the apparatus, as described, by which means we are enabled to effect the reduction of a very large amount of pulp with a comparatively small quantity of liquor, and preserve the requisite strength in the liquor, and also obtain facility for its evaporation.

We do not claim the use of hypochlorites for bleaching pulp, but we claim, secondly, the employment of hypochlorites in the process of bleaching straw or similar vegetable matter, when prepared as described, for the purpose of making paper, that is to say, using them at or about the strength set forth, viz., 3 degrees Baume; and we claim this degree of strength only when employed upon such materials.

Julius Herriet, of New York City, (assignor to J. Gaylord Wells, of Hartford, Ct.), for Elastic Type for Printing on Irregular Surfaces.

Claim.—Making by casting in moulds, or by pressure plates with raised characters or figures, the entire substance of such plates being sufficiently elastic as to adapt it to printing, as described.

A. O. Willcox, of Philadelphia, Pa., for Hot Air Engines.

Claim.—I do not claim the use of renovating discs outside of the working cylinder, either when alternately travelling through the heated and cold air, or when stationary, and alternately transmitting heated and cold air, as I am aware such have been before used.

I claim placing the economizing discs within or attaching them to the driving piston itself, whereby I am enabled to effect the complete rarefaction of the heated air, while the piston is descending, and before the cold air is again let into the cylinder, as described.

I also claim inclosing the exhaust end of each single acting working cylinder, with an air-tight head, when combined with a self-acting valve, which opens from said exhaust end of the cylinder into the eduction pipe, in order to exclude the external atmosphere; and also for the double purpose of enabling any degree of rarefaction to take place within the exhaust end of the cylinder, without the return of air from the reservoir, and to allow the spent air finally to escape to said reservoir, as set forth.

I also claim inclosing each working cylinder within a jacket (of any suitable material), regularly increasing in thickness from the bottom to the top, in such a manner that when it is surrounded by water or other fluid, the temperature of the working cylinder will be kept reduced to a proper and nearly uniform degree (without much waste of heat), so as not to injure the lubricating fluid inside, whereby I am enabled to apply the heat of the furnace immediately under said cylinder, thus obviating the use of an expansion heater, as described.

G. T. Parry, of Spring Garden, Pa. (assignor to John Rice, of Philadelphia, Pa.), for Anti-Friction Boxes.

Claim.—Making the rollers in the form of double frustrums reversed, and united at their bases, and travelling in circular grooves of nearly corresponding form of the surfaces between which the rollers are interposed, as set forth.

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Written for Appletons' Mechanics' Magazine.

Mechanics for Practical Men.—Strength of Iron.

Cast-Iron.—This material, which has come to be used so extensively in the arts, and in constructions, and whose uses are daily extending, has been made the subject of a great number of experiments. The most recent and reliable are those of Mr. E. Hodgkinson, the English experimenter. Those especially made by him on the strength of columns, both solid and hollow, and the most suitable forms for cast-iron beams to sustain a transverse strain, have supplied the engineer and architect with the most valuable guide in using and adapting this metal to the various purposes of construction.

Resistance to Extension.—Experiments have been made on this point by Mr. Rennie and Captain Brown, of England, and under the direction of the Franklin Institute in this country, and also by Mr. Hodgkinson of England. The first-named gentlemen obtained for the ultimate tensile strength of cast-iron, from 14,000 to 18,000 pounds per square inch of cross section. The results obtained by Mr. Hodgkinson, also on English iron, both hot and cold blast, was from 12,000 to 19,000 per square inch.

The experiments by the Franklin Institute on American cast-iron give for the mean tensile strength, 20,834 pounds per square inch. This material, however, on account of its brittleness, and comparatively low power of resistance to a strain of extension, is seldom ever submitted to it. It is much used in the shape of cast-iron beams, to resist a transverse strain, but this has been shown to be nothing more than a strain of compression on one part, and of extension on another part, of the same piece. In large works, it would be much better to use a combination of cast and wrought-iron for resisting a transverse strain, the cast for compression, and the wrought for extension.

Care must be taken, however, that the different degrees of expansion of these two materials by heat, produces no injurious effects. The limit of elasticity as assigned by Claudel, is $\frac{1}{1288}$th, and the force necessary to produce it 16,100 pounds per square inch. Some few remarks on the characteristics of cast-iron may not be out of place here. (They are mostly from the pen of Professor Mahan.) Cast-iron is divided into two distinct varieties, the white cast-iron and gray cast-iron. There are of course intermediate varieties, which partake more or less of the properties of these two, as they approach in appearance nearer the one or the other.

Gray cast-iron when of good quality is slightly malleable in a cold state, and will yield readily to the action of the file, when the hard outside scale caused by the chill in casting is removed. It is also sometimes termed soft gray cast-iron; it is softer and tougher than the white iron. On striking a sharp corner with the point of a hammer, an indentation will be produced, when in the other variety a piece would fly out. When broken, the surface of the fracture presents a granular structure, the color is gray, and the lustre is what is termed metallic, resembling small brilliant particles of lead strewed over the surface.

White cast-iron is very hard and brittle; when recently broken, the surface of the fracture presents a distinctly marked crystalline structure. The color is white, and lustre vitreous or glassy.

The following description, from Mr. Mallet's Report to the British Association for the Advancement of Science, comprises the different varieties:

"*Silvery.*—Least fusible, thickens rapidly, when fluid, by a spontaneous puddling; crystals vesicular, often crystalline; incapable of being cut by chisel or file; ultimate cohesion a maximum; elastic range a minimum.

Micaceous.—Very soft; a greasy feel; peculiar micaceous appearance, generally owing to excess of manganese; soils the fingers strongly; crystals large; runs very fluid; contraction large.

Mottled.—Tough and hard; filed or cut with difficulty; crystals large and small mixed; sometimes runs thick; contraction in cooling a maximum.

Bright Gray.—Toughness and hardness most suitable for working; ultimate cohesion and elastic range generally are balanced most advantageously; crystals uniform, very minute.

Dull Gray.—Less tough than the preceding; other characters alike; contraction in cooling a minimum.

Dark Gray.—Most fusible; remains long fluid; exudes graphite in cooling; soils the fingers; crystals large and lamellar; ultimate cohesion a minimum; and elastic range a maximum.

The gray iron is most suitable where strength is required; and the white where hardness is the principal requisite."

The color and lustre presented by the surface of a recent fracture are the best indications of the quality of iron.

A uniform middling dark gray color and high metallic lustre are indications of the best and strongest. With the same color, but less lustre, the iron will be found to be softer and weaker, and to crumble more readily. Iron without lustre, of a dark and mottled color, is the softest and weakest of the gray varieties.

"Iron of a light gray color, and high metallic lustre, is usually very hard and tenacious. As the color approaches to white, and the metallic lustre changes to vitreous, hardness and brittleness become more marked, until the extremes of a dull or grayish white color, and a very high vitreous lustre, are attained, which are the indications of the hardest and most brittle of the white variety.

"The strength of cast-iron varies with its density, and this element depends upon the temperature of the metal when drawn from the furnace; the rate of cooling; the head of metal under which the casting is made, and the bulk of the casting.

"The density of iron cast in vertical moulds increases according to Mallet's experiments, very rapidly from the top downward, to a depth of about four feet below the top; from this point to the bottom, the rate of increase is very nearly uniform.

"All other circumstances the same, the density decreases with the bulk of the casting; hence large, are proportionally weaker than small castings. From all these causes by which the strength of iron may be influenced, it is very difficult to judge of the quality of a casting by its external characters: in general, however, if the exterior presents a uniform appearance devoid of marked inequalities of surface, it will be an indication of uniform strength."

There has been considerable discussion with regard to the relative merits of hot-blast and cold-blast iron. Messrs. Fairbairn and Hodgkinson have investigated the matter, and their conclusions are expressed in the following paragraph: "The ultimatum of our inquiries made in this way stands in the ratio of strength; 1000 for the cold blast to 1024·3 for the hot blast. The relative powers to sustain impact are likewise in favor of the hot blast, being in the ratio of 1000 to 1126·3."

The durability of cast-iron under exposure depends on different circumstances, the bulk of the casting, its homogeneity and density, &c. Mr. Mallet has made researches on this subject, and the following are the conclusions he arrived at:

"That the decay of iron, when exposed to the action of water, is principally due to Voltaic agency, especially in tidal rivers, where there are strata of different densities, a Voltaic pile being thus formed of one solid body, and two fluid ones, making the corrosion much more rapid than where the water is homogeneous. Pure sea-water has much less action on iron than the water of harbors and docks, owing to the hydrosulphuric acid contained in the latter, and which comes from the mud at the bottom. In sea-water (pure) the rate of corrosion of pieces one inch thick, is four-tenths of an inch for cast-iron, and six-tenths for wrought-iron per century. In fresh water, the corrosive action is much less than under any other circumstances of immersion, the coat of oxide formed on the outside not being dissolved and washed away as in sea-water, but remaining as a kind of protection. In hot sea-water, the corrosion is most rapid of any other circumstances. Iron, chill cast, corrodes more rapidly than when cast in green sand, by reason of the want of homogeneity of the metal, thus forming Voltaic couples of different densities. When soft and hard cast-iron are brought together under water, the soft is corroded much more rapidly than when by itself, while the hard suffers much less; castings made in dry sand are more durable in water than those made in green sand. From one-eighth to one-fourth of an inch on the outside of castings, is the term the hard crust. When this is removed, the iron corrodes much more rapidly. The chief point in making castings to be exposed to this agent, is to have them as homogeneous as possible, and of as great density."

Mr. Mallet concludes with the following very judicious remarks: "The engineer of observant habit will soon have perceived, that in exposed works of iron, equality of section or scantling, in all parts sustaining equal strain, is far from insuring equal passive power of permanent resistance, unless, in addition to a general allowance for loss of substance by corrosion, this latter element be so provided for, that it shall be equally balanced over the whole structure; or, if not, shall be compelled to confine itself to portions of the general structure, which may lose substance without impairing its stability."

[To be continued.]

The Caloric Engine.

Some apology may be thought due for again reverting at any length, editorially, to a subject which has been so deeply discussed in the preceding pages by Maj. Barnard and Capt. Ericsson. A simple sketch of the present condition of the enterprise may be all that is necessary, although, in doing so, a familiar and rapid glance at all the principal questions involved may be interesting to those who have not followed the thread of the more serious arguments.

The caloric ship *Ericsson* is now lying at the dock of Messrs. Hogg & Delamater's works, foot of North 13th Street. All the supply and working cylinders of the original construction have been removed entirely, with their pistons, heaters, levers, regenerators, and air pipes. On the other hand, there have been retained the bed-plate, the principal framing, shafts, cranks, the beautiful valve movement, and even the connecting rods which, in the old arrangement, transferred the motion from the working beams to the crank. In place of the four huge sets of cylinders standing perpendicularly, there are to be two moderately-sized cylinders on the line of the keel, and inclined towards each other, making an angle with the keel of about 45 degrees. The supply cylinders are of the same stroke, four in number. One is placed on each side of each working cylinder, and worked from the cross-head, in the same manner as pumps are often placed, on each side of the air pump in condensing marine engines. It will thus be seen, that the present engines of the Ericsson comprise two working and four supply cylinders. The working cylinders are each six feet in diameter, with eight feet stroke. Speaking theoretically of both arrangements, these two moderate-sized double-acting engines, are designed to be as efficient as the four large single-acting ones previously employed, in consequence of working with a higher pressure. *In these engines the same air is to be used repeatedly under a high pressure.* This is *the* difference between the present and the former engines of the Ericsson. The regenerator, in a different form, but acting on precisely the same principles, and with, it is presumed, precisely the same effect for good or ill, is retained, and continues to be relied on as the chief economic feature. This is the fundamental feature of the caloric engine, and the supposition that it had been given up, would be equivalent to supposing the caloric engine "an obsolete idea," which is yet far from being the case.

The above facts have been courteously furnished, at our solicitation, under the pledge that we make no professional criticism until it is brought out, which will probably be in about two months. How far in these prominent features the engines differ from, and also how far they correspond with, the former arrangements, will readily be perceived. So far as the decision of bets, &c., are concerned, we decide without hesitation as follows:—If the bet was on those particular engines, whether THEY would ever take the ship to Europe, &c., the "engines of the Ericsson" and their backers have lost; but if the stake was on "Ericsson's Caloric Engines," the question is still undecided.

The engines now being set up in the ship, are on a plan more nearly resembling the earlier designs and patents of the same inventor, which have been published in Sir Richard Phillips' Arts of Life: 1833, London, and various other works; the air being first very much condensed, and then successively heated and cooled.

The air in the new engines will be previously condensed by a small auxiliary engine, to a pressure of several atmospheres. In the operation of the engines, the cold air will first be pumped by means of the supply cylinders, through the regenerator into a heater, where it will assume a still higher pressure.* In this condition it will pass into the working cylinder, and by its difference of pressure, *i. e.*, its excess over the pressure common to the cold condensed air, will drive the piston to the end of its stroke. It will then escape through the regenerator (in which it will leave most of its heat) into a cooling vessel, where it will come in contact with pipes or other surfaces kept cold by a circulation of sea-water from the outside of the ship. Here it will assume the lowest pressure possible to its condensed condition, and be ready to repeat the round of operations. To render the matter still more familiar, let us follow the same quantity of air, *i. e.*, one cylinder full, through the circuit again. Cold air, at a pressure of, say six atmospheres, is compressed by the pistons of the supply cylinders to, say half its bulk, or about twelve atmospheres, passes through the regenerator, and is heated to 480° more or less, which expands it to its initial volume, but with double pressure. With this surplus pressure, *i. e.*, twelve atmospheres acting against six, it drives the working piston, till at the end of its stroke it escapes at a pressure of only six atmospheres through the regenerator (where it deposits its heat and contracts its volume) into the cooler. The operation, therefore, consists of alternate mechanical compression in the supply cylinders, expansion by heat in the regenerator and heater, work and further mechanical expansion (if a cut off is used) in the working cylinder, and exhaustion through the regenerator into the reservoir of cold.

The caloric engine has, as we intimated at the commencement of the volume, been a most prolific subject for scientific study. No question comparing with it has arisen in the engineering world, since the great discussion in the last century concerning what should be the measure of momentum. Engineers and savans are as yet far from agreed with regard to its theoretic merits; meanwhile, revolution has been partly effected in the theory of the relation of heat to power. Heat had been formerly believed to give out power in its mere diffusion, the same amount of heat, sensible and latent, being supposed to remain in the exhaust steam as was contained in the steam entering the cylinder, excepting waste by radiation. The only change supposed to be effected in the heat by working, whether in a steam, mercury, air, ether, or other caloric engine, was its change from a sensible to a latent condition, or else its diffusion by distribution throughout a greater quantity of matter. In the non-condensing steam engine, steam enters the cylinder at a pressure of 100 lbs. above the atmosphere; the sensible heat is about 340° F. The same steam escapes at atmospheric pressure from the cylinder, and its sensible heat is now 212° F., but its latent heat is proportionably increased. The only change in the condition of the heat is this—it is now in a larger space, and a greater proportion of it is latent. There is the same quantity of heat there. The steam will melt the same amount of ice (or warm the same number of rooms in winter, if carried in pipes about a building) after its work in the engine as before.

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* The critical reader will perceive that the language here is not strictly accurate, but near enough for our purpose. The pressure is no greater in the heater than when it leaves the supply cylinders, and the pressure in the cooler can be of course but very little less than when it first leaves the working cylinder.

This, be it understood, is but a brief exhibition of the old doctrine, if there may be said to have been *any* heretofore existing on the subject. We would not, in this superficial survey of the case, be understood as throwing the trifling weight of our personal opinion in favor of this or of the new theory, further than to confess firm belief in this doctrine heretofore, and a degree of "old fogy" tenacity in clinging to it. The new theory, to which two articles in this number are devoted, supposes a disappearance, an absolute annihilation of heat in performing mechanical work. One lb. of steam enters the cylinder containing heat enough to melt five lbs. of ice; it escapes from that cylinder containing only heat enough to melt four lbs. and fifteen ounces. The heat necessary to melt one ounce of ice has disappeared. Where has it gone? (We have already supposed no loss of heat by radiation, or have supposed such losses otherwise compensated for.) The steam has been generated, has absorbed a certain amount of heat from the furnace, has passed through the engine, and reappeared on the other side, containing less heat in total amount, latent and sensible, than before. This process has been continued all day, or during a whole voyage from New-York to Chagres, and yet the cylinder which is absorbing it all grows no hotter. The new theory explains this fact, or rather this apparent result of experiments, by saying that heat is always lost, spent, or annihilated in doing work. It assumes that there is always heat annihilated in proportion as there is work performed. If an engine is expansive, and very efficient in proportion to the steam used, more heat is missing from any given quantity of steam than from an equal quantity passing through an imperfect slam-bang engine.

It has practically no appreciable influence on the value of the regenerator engine (for such we may term the Ericsson engine in distinction from steam and other caloric engines); the regenerator is practically as valuable or as faulty whichever theory be established. All the heat transferred thereby is a saving of heat; all the power consumed in passing the fluid through its labyrinthine passages is a loss of power. The saving of heat is beneficial; the throttling of the fluid is injurious. Just as these simple elements prove in practice to be proportioned to each other, so is the regenerator beneficial or otherwise.

A regenerator may be constructed to transfer a small portion without creating any serious resistance, but in proportion as its heat-saving efficiency is increased, the throttling is increased in a greater proportion. The heat-saving efficiency may thus be increased, until a certain limit is reached where any increase in this respect will be accompanied by an equal increase in the resistance from this cause. This is the condition of its maximum value. If the attempt is made to make the regenerator still more effectual in economizing the heat, this encumbrance will overbalance the beneficial effects, and each successive addition will be an obstruction, until, in an extreme case, the whole regenerator will be a nuisance, and its entire removal would be an improvement upon the engine.

But the case is entirely different when the following question alone is considered:—What percentage of the whole heat used in one cylinder full of fluid may possibly be extracted and infused into the succeeding one by any means, known or unknown? It is easy to see that by the new theory, from 2½ to 5 per cent., more or less, has been annihilated, or "transformed into mechanical work," in either of which conditions it would be "past praying for," and only from 95 to 98 per cent. possibly remains to be recovered. By the old theory, on the contrary, the heat not being consumed, but only diffused, &c., by the operation it has undergone, mathematicians and others have room to dispute on the abstract possibility (all other conditions being set aside) of recovering *all* the heat, and making the engine a perpetual motion.

But while the savan is engaged with his 5 per cent., the practical engineer looks with an eager eye at the remaining 95, which, as this discussion informs him, is now being thrown away. If the caloric engine never accomplished more in this connection than to bring this fact down within the range of the engineering community, the said engine would be to the public, if not to its proprietors, a great and lasting benefactor. The fact that such is the case, not perhaps in precise accordance with these figures, but to a point somewhere approximating to it, is now forced upon our attention, and the ten thousands of chemists, engineers, and inventors of our own and other countries, are wide awake to its importance, and actively deliberating on the various plans for economizing, not the whole or the half, but even the tenth part of this now wasted heat, without involving disadvantages as serious or more formidable than the present loss of coal.

The new engines of the Ericsson will operate on precisely the same principle, so far as the regenerator is concerned, as heretofore. In one point of view they are precisely similar engines, but working in an artificial atmosphere of several times the normal pressure. Referring back to page 82 of the present volume, and substituting 100, or any other number of lbs., for the 15 introduced in those formulas, the admirable mathematical analysis of the engine then given, applies as exactly to the new as to the old engine, so long as it is purely general. In being required to apply his theory to the actual operations of an engine, he had never seen even a correct description of, Maj. Barnard labors under a difficulty which will be readily appreciated. By substituting *c* for the 15 used in Maj. Barnard's formulas, and making *c*—the pressure of the condensed air in the "cooler" of the new engine,—we see no reason, at the present moment, why the formulas do not apply throughout, in every proportion of the cylinders, position of the cut off, and temperature in the heater.

This brief survey of the present position of the case may satisfy a large and respectable class of practical men who have not dived very deep into the arguments of the propriety of devoting much of our space to this subject, although we took a decided stand against the extravagant claims set up for it by the reporters. The *New-York Daily Times*, a very spicy and enterprising paper, by the way, triumphantly launched at us the question, which it is no doubt ready by this time to answer for itself,—"Is the press a safe exponent?" Most emphatically, it is not. We provoked a powerful enemy in speaking contemptibly of the daily press who were placing Capt. Ericsson ahead of Watt, but trusted to time to correct any prejudices so aroused.

The 86 inch engine by Capt. Ericsson, which was nearly prepared for the Crystal Palace Exhibition, will, we are assured, be in operation at the American Institute Fair in this city in October. Meanwhile, preparations are making for permanently driving machinery in Messrs. Hogg & Delamater's works by the same 72 inch double engine represented in the plate in our February number. It appears that at the very time when we announced (June 1st) that the experiments *appeared* more backward, &c., there were something like 800 men employed on work connected with the present and other engines. This is the only mistake of importance to be corrected, and, as intimated at the time, we spoke then only of what appeared upon the surface. For the accompanying *facts relating to the new engine* we have Capt. Ericsson's direct authority.

Correspondence.

[For Appletons' Mechanics' Magazine.]

On Warming and Ventilating Houses.

No. 3.

(*Continued from page* 190.)

Most of the enormous hot-air furnaces in use are placed in brick chambers, the construction of which constitutes an additional expense, such as can be borne only by the wealthy. They are generally placed in cellars, and other underground situations, where the pure air of heaven cannot reach them. The foul pent-up vapors, lurking in these dark dungeons, have been generated, or forced into these furnace-chambers, there warmed, and thence transmitted through the entire building, to be breathed, perhaps, by human beings, whose health depends almost entirely on a proper and healthy respiration. So, too, in the ground or upper floors, where the only air generally afforded to be warmed is that which the room itself contains, or which may, perchance, obtain inlet through cracks and crevices in the windows, or the stray opening of a door. Thus the same air may be baked over, so to speak, one or more times, with but a very slight accession of any new or fresh air to its original volume. In addition to this, the air of the room is inhaled perhaps by many people, as a congregation in a church, or a party, or social gathering, and thereby rendered still more unhealthy and unfit for respiration; diminished in oxygen and increased in carbonic acid; the latter a gas fatal to animal life, when existing in the atmosphere to a greater extent than ten per cent.

It is almost self-evident, that every particle of air suffered or allowed to be heated, should come from some healthy source, independent of the air already in the room, particularly so, after the air of the room has wholly or partially undergone the heating process; for then the demand for new air is more apparent, in order to prevent a baking of the original air over again. The best mode of accomplishing this part of the warming process must vary with the circumstances. In the case of brick-inclosed furnaces, especially those located below the level of the ground, no air from the damp vaults should be allowed to enter them. Windows opening or leading to the open atmosphere, or suitable and sufficient air-flues or pipes, should pass to the outside of the building, and no air should be furnished to the furnace, save through some legitimate exterior communication, as the kind last suggested. There will be no difficulty in accomplishing this result, as the apparatus, when in action, will generate its own current. Particular care must be taken to place the exterior aperture sufficiently high above the ground level, as to avoid the noxious gases lying near the surface, and generated by vegetation in low or marshy situations. In church-yards, it should never be placed near the foundation. The walls may easily contain the supply air-flues, with ornamental apertures adjustable like the ordinary registers. These little points, trifling as they may appear, nevertheless are very important to the sum of man's existence.

It must be confessed that it will be an extremely difficult matter to apply this thought to stoves, as ordinarily used. They generally stand on independent legs, resting simply on the floor, their heated metallic surfaces exposed to the air of the room, which thereby becomes heated, and rendered sufficiently warm for useful purposes. The true way is to introduce new, fresh air from the outer atmosphere, and cause the same only to act upon these exterior heated surfaces. To do this, there must be a radical change in their construction, otherwise the air of the room will for ever be attracted to their heated sides, and its original volume thereby radically changed. A simple mode might here be suggested. Inclose the stove in a sheet-iron chamber or cylinder, extending close to the floor, and communicating through the floor or through the wall to some external source, by means of a flue or pipe. The surrounding cylinder should be sufficiently distant on all sides from the stove inclosed therein, so as to give proper space for the fresh currents that will continually pass between the sides and within the hollow chamber. The top of this chamber should be open, so that the warm currents may pass freely into the room. It is evident, that by this arrangement but little of the air already within the room is warmed by contact with the heated stove, but only air coming from a pure external source, so that no air is baked over again, and its healthy constituents thereby destroyed. The room is warmed by the accession of heated volumes, foreign in their source, not by the gradual heating of its original volume. The subject of sufficient apertures near the ceiling, for an escape of the noxious gases unavoidably generated during the heating process, will be duly considered hereafter.

In regard to grates, an important fact might here be suggested, which seems to have been entirely overlooked in these latter days. As ordinarily used, nearly all the heat that is obtained from grates is by direct radiation. If the heat could be made visible, it would appear like right lines diverging in all directions from the fire, and penetrating into the room like rays of light. The fire itself, however, has a direct communication with the chimney, through a large and generally unobstructed flue. Towards the opening to this flue, a strong current of air is naturally generated, so that if the rays of heat were visible, they would be seen bent or twisted backwards, in the direction of the opening. Hence the current carries them up the chimney, and thence to the open air, thus lessening the quality and quantity of caloric thrown out or radiated, and reducing to an enormous extent the power of the combustion for useful purposes. The unobstructed flue (with which we find no fault—would that we had more of them), affords, in addition, freedom to a large amount of heat; for the air in the room already warmed is, perchance, impelled by this same current, and by its own nature, in the direction of the flue opening, and thence up the chimney. To compensate for the amount of heat thus wasted, the size of the grate is enlarged, and the consumption of fuel increased, so as to meet the emergency, and make up for this unnecessary loss.

Since the days of the old hearth-fire, and the introduction of coal, grates have been and ever will be popular. They are the only apparatus in ordinary use that can compensate in any way for the loss of the cheerful light and blaze of the huge hearth-fire and quaint fireplaces of the olden time, and sooner than part with their pleasant glow and enlivening appearance, the consideration of expense in their use is thrown aside. People are willing to pay for the light of a grate-fire, for it is a comfort to them. On the other hand, the dark bastile-like stove has its fire imprisoned in its brick-lined chamber, invisible to mortal eyes. In addition to this, the stove generally and necessarily stands out far into the room, occupying much valuable space, and constituting an unpleasant eye-sore, with no inconsiderable smell.

There are many inducements, therefore, for clinging to grates, regardless of expense. Their cheerfulness is more than an equivalent for their extra consumption of fuel. Their location in the wall is favorable to space, a matter of much importance in every household. Many a long evening is merrily spent without the aid of candles, and many a quiet reverie is engendered while gazing into their glowing masses.

Smoke, too, is disappearing. It was the theme of poets, when it was seen curling gracefully from the chimney tops, and it delighted the weary traveller when way-worn he stood, perhaps, upon some hill that overlooked his native village, and beheld it rising from every flower embowered cottage—

"Et jam summa procul villarum culmina fumant."

But coal has abolished all this, and nothing is now seen, save a diabolic flame at night, like the incantation caldron of the witches in Macbeth, pouring its sulphurous volumes from earthen or metallic pots, of fantastic man-like forms, frightening the belated wanderer, and hastening his steps to the safety of his own mansion. Our steamboats can no longer be said to pour forth flames and smoke, and ere long our locomotives will know it no more, for which millennium the writer most devoutly prays. We have no regrets at its departure, and wish it a long and a lasting farewell; and travellers generally, no doubt, will sympathize with us in our prayers for its exodus.

But not to digress further. The important fact, in relation to grates, which seems to have been overlooked, and to which we have alluded, is, that only one side or portion of their fire surface is made to emit heat, while three-quarters (the back and sides) are solidly and hermetically sealed in substantial and impervious masonry. The burning, glowing mass of coals, with latent caloric resources, and heating capacities of a prodigious character, is made only to radiate from a single outer surface (the face of the grate), and that rendered abortive, to a great extent, by the counter currents which we have just noticed passing to the chimney. Certainly the back and sides are heated, and have, consequently, air-warming qualities, and certainly (according to the present mode of construction), they are not allowed to send forth this heat, so that it may be rendered competent and useful, and the consumption of fuel thereby reduced. To obviate this loss, let the grate be made with a hollow chamber, extending entirely round the back and sides; if made of metal, it may be protected against the direct action of the fire by the ordinary brick lining. Adjustible register-like apertures from the room may open to this hollow chamber, near the floor, one for each of the sides, and one beneath the grate for the hollow back, so as to supply air for the heating process. A better mode would be, where circumstances admit of it, to open a direct communication from this hollow chamber to the open air, so that the only air afforded to be warmed will come from an external healthy source, and not from the room itself. The heating process is accomplished by the air thus introduced, passing upwards into contact with the heated back and sides, and thence into the room, by suitable adjustible openings, located anywhere above the grate or mantel, or by the ordinary tin flues to an upper chamber, or by similar flues to any other part of the house. It is evident that a large amount of useful heat will thus be developed, which, under the present construction, is entirely lost in a mass of solid masonry. Grates of this description, if of metal, might be kept ready made, fit for insertion at once, and all the annoyances of grate-setting avoided. The hollow chamber need not be more than two or three inches deep, so that a grate of this kind will occupy no more space than one of the ordinary form.

The dealer in hot-water furnaces claims for his apparatus a superiority which, if well founded, is of the most formidable character. He claims that air warmed by his furnace loses none of its vitality; that no part of it is or can be heated over 212 degrees; and that consequently it cannot, by any possibility, impart to the air coming in contact with it a higher degree of temperature than that which itself possesses. It is conceded, that air passing over heated surfaces having no greater degree of temperature than boiling water, loses none of its vitality; in other words, suffers no decomposition or resolution into its constituent elements. A hot-water furnace, therefore, if well constructed and properly arranged, so as to have free access to new, fresh air, will undoubtedly furnish a good quality of warm air, free from the feeling of dryness that characterizes air of a higher temperature, thus avoiding the damage done to houses by the shrinking, warping, and cracking of the windows, walls, doors, and furniture;—a consideration of itself, to say nothing of the health of the family, sufficient to more than compensate for the difference in the expense of the apparatus.

All the active properties of atmospheric air are referable to the oxygen which it contains, but which, for the purposes of animal existence, must be diluted and duly mixed. Without oxygen, no man could live. In pure oxygen, he might live for a short time, but his existence would be rapid, like the flame of a candle burning with too great intensity. All the vital functions would be increased to a morbid excess, and life would soon terminate in the blackness of death. Nitrogen is also speedily fatal to animal life. It is a gas of nearly the same weight with common air, not inflammable, but, on the contrary, instantly extinguishes all burning bodies introduced into it. With all its deadly properties, it nevertheless constitutes four-fifths of the atmosphere of our globe, for it is only when used by itself its influences are fatal. The due admixture of oxygen with it (constituting atmospheric air) is one of the most wonderful of the many wise organizations of nature; and so carefully has she protected us from fatal results, by an excess of either gas, that it has been found extremely difficult to make these gases unite to any considerable extent, save in the proportions constituting common air.

Combustion itself is only the result of the extraordinary affinity of the oxygen of the atmosphere, for the bodies which burn in it, and with which it is consumed. In pure oxygen, all combustible bodies burn with great brilliancy and splendor. Even wire and other metallic bodies are made to burn in it with a brightness unendurable to the human eye. It is during the action of this intense chemical affinity that light and heat are given off in abundance. M.

To be continued.]

New-Publications.

Plain Directions for obtaining Photographic Pictures. By J. H. Croucher. 12mo. pp. 224. Philadelphia: A. Hart, late Carey & Hart. 1853.

An apparently valuable and timely book on an interesting and important subject. Its title-page intimates its presenting all the latest improvements in fixing, coloring, and engraving the pictures. It includes picturing upon albumenised paper and glass by collodion, albumen, &c., a treatise on Photography, with a supplement containing the heliochrome process, and a series of practical hints on the daguerreotype.

Elements of Mechanism for the use of Schools and Students in Mechanical Engineering. By T. Baker, C. E., author of Railway Engineering, &c. 12mo. pp. 235. London: John Weale. 1852.

An easy and popular style is studied throughout this volume. It is very profusely illustrated, and contains many rare devices for producing varied motions; the greater portions, however, are credited to other and larger modern works. No labor seems to be expended in harmonizing the various terms liable to be confounded with each other, and there are passages which seem to indicate stupidity or carelessness either in the editor or the authors from whom he quotes. The operation of an hydraulic press worked by a steam-engine of 40 horse-power, employed in raising the tubes of the Britannia and Conway Bridges, is thus unphilosophically described, the italics being our own. "These pumps are 1 1-16 inch in diameter." "The power applied to the pump is thus increased in the ratio of the areas of 1 1-16 to 20 inches [20 inches being the diameter of the Ram] or as one to 355. If the full power of the engine equal to 40 horses, were exerted, *the available power thus produced in the press would equal the product of 355 and 40 or that of 14,200 horses!*" Upon a hasty examination, the book appears to be an interesting mass of patchwork, containing "243 engravings" with reading to match, but improper for schools, and discreditable to the name of Mr. Baker.

A Manual of Elementary Geology. By Sir Charles Lyell. 8vo. pp. 512. New-York: D. Appleton & Co. 1853.

This is a reprint from the fourth London edition, which was thoroughly revised and corrected by the distinguished author. The "Manual" is devoted to the geological monuments of the ancient condition of the earth's crust. Its style is easy and attractive in the highest degree, and the work, taken in connection with the "Principles of Geology" by the same author,—an American edition of which will soon be produced, in the same superior style,—is designed to present a complete and systematic view of the Science. The eminence of Sir Charles Lyell in this department is too well known to render comment on the matter of the work necessary. The volume is illustrated by five hundred Engravings.

Apprentices' Department.

Questions.

Question 20. The specific gravity of wrought-iron is about 7·8 (distilled water being 1). What will a cubic foot of wrought-iron weigh when immersed in fresh water?

Question 21. A certain anchor weighs 4,500 lbs.; of this weight 700 lbs. may be considered to be hard-wood stock, and iron hoops, which together are of about equal specific gravity with the water. What will this anchor weigh when inserted in sea-water?

Question 22. Would a bladder of atmospheric air lose its buoyancy, and commence sinking, if forced to a sufficient depth beneath the surface of the sea? and, if so, at what depth would this point be found, allowing nothing for the weight of the bladder itself, or for variations in temperature, and assuming the specific gravity of air under the usual pressure of 14·7 lbs. per square inch to be 0·00125, and of sea-water 1·026?

Question 23. Suppose a perpendicular hollow tower be constructed 300 feet in height (equal to that of the Latting Observatory in this city). Will a bullet dropped from the centre of its top strike in the centre of its base? if not, how much will it deviate therefrom, and in which direction?

Monthly Notes.

Geo. M. Ramsay, M. D., of St. Louis, Mo., proposes a new model for vessels, designed to crowd under, rather than divide and move laterally, the resisting fluid. This is attempted by giving the keel a gentle rise from the vicinity of the engine, which is near the after-part of the boat, toward each end, at the same time drawing together the lines from the sides in the usual manner. The effect of such a form is to partly divide and partly force under the water, the latter operation tending, by the reaction at high velocities, to elevate the boat, and diminish the area of mid-ship cross section. In the absence of experiments on any extended scale, Dr. R. fancies it possible to render this principle so far available, as to absolutely avoid any increase of resistance as the velocity is increased. The model shown us is very fine forward and full aft, in which respect it resembles many of the later yachts and fancy models. Its chief feature, however, appears to be gliding over rather than cutting through the brine, and, if successful, even to a fraction of the hopes of the inventor, it will be an important step toward "fast" navigation.

The Board of Supervising Inspectors of Steamboats held a meeting at Pittsburg on the 1st inst., and continued by adjournments up to the 5th. "They adopted resolutions," says *The National Intelligencer*, "directing the local inspectors to again call the special attention of owners of steamers to the importance of having, where practicable, a steam-pipe from the boilers to convey steam into the hold, for the more effectual extinguishment of fires; also, that shoulder-straps be attached to life-preservers, or other means used for preventing them from getting into an improper position, to the hazard of life; that printed notices be posted in all state-rooms or berths, informing passengers where the life-preservers may be found, and the manner of using them; that fire-hose be either constantly connected with the pumps, or placed in a convenient and conspicuous position therefor; that explosive articles be conveyed only in secure metal-lined chests, and that materials which ignite by friction be kept at a safe distance from explosives; together with other regulations of a more technical description, but extremely useful and requisite."

The interregnum still continues in the Engineering department of the navy. There is yet no Engineer-in-chief. Gen. C. B. Stuart, who commenced the duties of the office, Oct. 1, 1849, resigned about July 1st of the present year. We would continue to urge the appointment of some practical man to this highly important situation. The place has been tendered to Mr. C. W. Copeland (who, it will be recollected, was "principal engineer" from 1809 to 1851), but has been formally declined.

Ballooning in Siberia.—A Siberian correspondent of the "Independance Belge" gives an account of the introduction of aerial navigation for practical purposes in that country. It seems that the enormous quantity of water produced by the melting of the snow, occasions a great rise in the rivers in the spring of the year, intercepting the communication between certain manufacturing works on the Oural, at the distance of three and a half versts from each other, and separated by a small stream. In order to keep up the communication, and permit the workmen to pass and repass, a large stationary balloon is fixed by three cords over each of the factories, at the height of about 200 metres. From each of these balloons is suspended a cable, reaching to the opposite factory, where it is attached to timbers constructed for the purpose. Between these two points, the cable is also supported by three intermediate balloons. The principal cable is provided with a pulley, on which is hung a light sheet-iron boat, holding two or three persons without inconvenience. The pulley itself is commanded by two cords attached to the opposite points, permitting the boat to be drawn toward either factory at pleasure. The cord designed to draw up the pulley after it has descended on the cable, and from which the vehicle has been detached, passes over a small pulley connected with the lower part of the balloon, so that these two cords, and consequently the pulley to which they are attached, are managed by persons on the ground. The main pulley has also an arrangement for the convenient mounting of the boats, subject to the control of the passengers, and the boat is provided with a parachute in case of accident. Thus far the contrivance has worked in a very satisfactory manner.—*Exchange paper.*

That will not compare with many of the discoveries of Baron Munchausen, and should not be thought of as a parallel to Locke's "Moon hoax." The story is going the rounds quite extensively, however, and has been published, perhaps originated, in one of the most prominent French Scientific Journals, a fact which entitled it to some notice. A verst is about 0·6631 mile, and a metre 3·28 feet, the former being a Russian and the latter a French measure. The balloon bridge then would be a little over 650 feet high and 2 miles long. A great difficulty in the way of such a bridge is the leakage of balloons. No construction of the kind will sustain itself but for a few hours.

Recent Experiments with Shot and Shells.—An extensive series of experiments have been instituted in Portsmouth harbor during the past week, with a view to ascertain the probable effects of the general introduction of shells in warfare afloat. The firing took place from the Excellent, upon the old hull York, 74, and on Saturday his Royal Highness Prince Albert arrived in the Fairy from Osborne to witness the practice. The experiments were highly interesting, and the following have been among the observed results:—

Shot being fired at shells fixed in their places ready for action on board the hulk, the shells in two instances were broken, and fragments thrown along the decks, the fusees not ignited, but the powder exploded by sparks from the friction of broken cast iron. With hollow shot, the results were the same; the shells were split as before, but not burst, no ignition of the fusee having taken place. Hollow 10 inch shot were split also in like manner. In one instance the powder was scattered, but not ignited, and several live shells were thrown out of their boxes uninjured. Some shot, at a short range, fired a pile of shells, one of which split, causing the explosion, by friction, of the burning powder, which, driving off the fusee-caps of two other shells, fired the fusees, and exploded the two. After the fusees had properly burnt their time, other shells were thrown to the right and left, but were uninjured. Shells were also fired at the hulk, while powder-cases, with the usual two cartridges, were placed as if in charge of the boys; the cases were thrown about, but the cartridges were not fired by the explosion. These experiments are to be continued, and no expense is to be spared to ascertain practical results of this nature.

London Mechanics' Magazine.

Additions are daily made to the articles on exhibition at the Crystal Palace, and the machine arcade is about opening. Exhibitors are invited to put themselves in communication with us, and we will endeavor in our next and succeeding numbers, to bestow upon the exhibition, and the more important of the articles, that careful attention which their importance demands. And in this connection we would urge the importance of making the awarding of prizes something more than a mere form, by practically testing such of the wares as it is possible so to do. Preparations had been made for testing by friction brake the power of the air engine of Ericsson, in which the able superintendent of machinery was perfectly justified, but why not take the same course on other subjects where it is practicable? Construct, as may be done at reasonable expense, a suitable dynamometer for measuring the power of the fancy engines, the presses, the rotary, centrifugal, and other pumps, and report the result. Test the crucibles, the fire annihilators, the fire-proof safes, &c., by putting the same or similar ones to those on exhibition, to a repeated and severe practical test. This might be done, under the auspices of the association, at least with such articles as the rival manufacturers themselves were willing to bear the expense of testing, and the report would do more to establish some one or the whole of those tested in the confidence of purchasers than any other advertisement. Let this plan be considered by all the parties.

A style of engine similar to the steam engine, but actuated by vapor of ether or other volatile liquids, has been announced as in course of successful experiment in France. An economy of 75 per cent. in fuel has been claimed as the result of this substitution of ether for water, and some one has wasted much good ink in detailing the advantages which will accrue. The mere exchange of one liquid for another in the boiler *cannot* of itself effect *much* economy, but the engines may use both steam and ether, using the heat in the exhaust steam, &c., to evaporate the latter. We design to take up this subject and give it a familiar explanation on some not very distant occasion.

The atmospheric telegraph, briefly noticed a few months since, as proposed by Mr. I. S. Richardson, of Boston, deserves a further notice. Mr. R. has an office at the Merchants' Exchange, and is endeavoring, with good prospect of success, to form a company to purchase his patent and construct such a telegraph, first from Boston to Worcester, thence to be extended, if successful, to New-York and elsewhere. The plan, as before stated, is to impel a piston from one place to the other very rapidly through an air-tight tube, either by a vacuum in front or a surplus pressure behind. The tube proposed is of southern pine, made of staves and hooped together, the internal diameter being 24 inches. The piston is of iron, somewhat too small, the edges of an accompanying disk of leather, somewhat too large to fill the bore, being supposed to adapt itself to all the inequalities, and make it travel air-tight. Admirable provision is made for cushioning the piston upon a quantity of air at the termination of the journey, so that its momentum shall be gradually stopped, and the same arrangement is made at all the way stations. Any number of air-pumps may be employed along the line, so that the successive journeys or jumps of the piston may be performed very rapidly, the whole time promised between Boston and New York being about fifteen minutes. The stout leather mail bag is to be dragged behind the piston, by being simply attached to its rear in the centre. We cannot make this consist with our ideas of good work, but it might be readily proved by trial. In October and November, 1851, a lead pipe three inches in diameter, and a little more than one mile long, was in operation for five weeks near Boston, and a similar plunger driven through it without perceptible wear or heating, either of the piston or small leather bag attached, although a subsequent examination proved much of the interior of the tube to be lined with grit which got in by carelessness in connecting the lengths. This would suggest a difficulty, and possibly a serious one, which might result from leaks along the line, that of sucking in and distributing foreign matter over what should be a perfect and well-greased surface. Mr. Richardson is sanguine of success in overcoming all obstacles, real or imaginary, among which latter he classes the probability of injuring the bag and its contents in passing through curves, and also over the straight portions of the tube at such high velocities. Mr. S. and his coadjutors have certainly the best wishes of every one for their success.

The American Institute, as will be seen by the advertisement, has lost none of its activity in consequence of the Crystal Palace Exhibition. Articles will be received on the 1st, and the Fair at Castle Garden will open for visitors on the 6th of next month.

To Readers and Correspondents.

Capt. Ericsson wishes us to say that his time is too much occupied to conclude, or even to continue, his article on the Caloric Engine this month, but that he will conclude in the next two numbers.

S. B. D., Mass.—The Engines, Boilers, Coal Bunkers, Shafts, Wheels, and spare apparatus of each of the Collins steamers weigh about 800 tons, excepting the "Arctic," the Engine department of which latter weighs nearer 900 tons. This is exclusive of the water in the boilers, which would add about 50 tons.

B. G. Mass.—The Dr. Mantell you refer to, was probably the distinguished Geologist, Gideon Algernon Mantell, L.L.D., F.R.S., &c., who died in London, Nov. 10, 1852.

"X."—Less even than you suggest is now assumed by medical men. In fact the amount must vary greatly with individuals, or even with the same individual, at different times, but the whole quantity of blood in the average of healthy human adults is now understood to be 18 instead of 25 or 28 lbs.

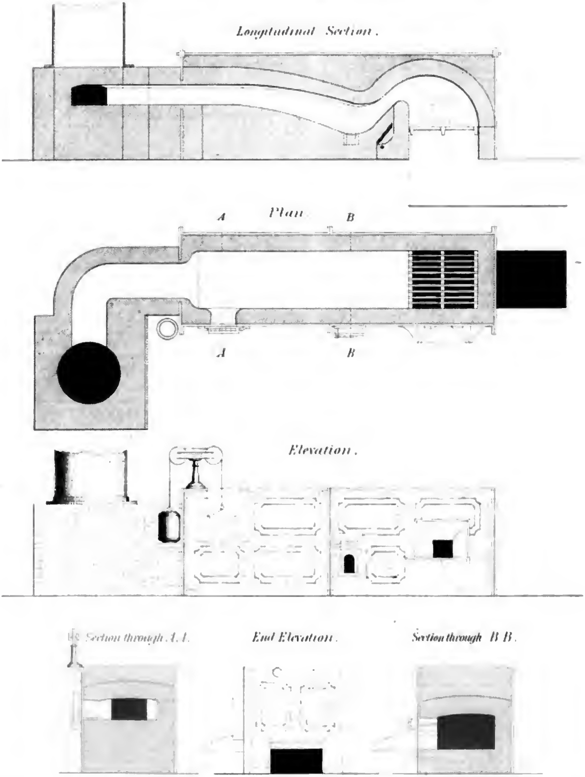
L. B., Mass.—Have sent you the information by mail.

E. H. H., Penn.—We will act on your suggestion, but are not at present prepared to furnish any information of importance.

S. M. L., Quebec.—Your communication was intended for appearance in this number, but was mislaid. We will inquire personally and inform you by letter, after which, will you favor us with a more detailed article?

AIR FURNACE FOR BRASS FOUNDRY

as arranged at H. B. M. DOCKYARD Woolwich. England.



Longitudinal Section.

Plan.

Elevation.

Section through A A.

End Elevation.

Section through B B.

Scale 1 inch 4 feet.

Appleton's Mechanics' Magazine Oct^r 1853

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A P P L E T O N S'

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[To the Editor of Appletons' Mechanics' Magazine.]

THEORETICAL INVESTIGATION OF THE CALORIC ENGINE—Continued.

By J. G. Barnard, Brev. Maj. U. S. Eng.

The following paragraphs are submitted to elucidate and fortify the positions assumed by me in my paper of July, entitled a "Theoretical Investigation of the Caloric Engine." A considerable portion of that paper was written in haste, and want of time and space did not permit me to make the investigation as complete as it should be.

Having, in my first attempts to calculate the mean working pressure of the engine, made use of an averaging formula, I introduced it into the paper for want of time to seek further, though it was clumsy in form and not perfectly accurate.

I shall now introduce a new formula, deduced directly from Poisson's formula for the pressure, in terms of density of an elastic fluid.

Calling, as before, the tension of the air in reservoir and working cylinder before the cut-off, t, but calling the portion of stroke up to cut-off, l, instead of x as before; the whole stroke being unity, the mean pressure developed by the expanding air after the cut-off will be obtained as follows:

Supposing the piston to have passed over a portion of its stroke, denoted by z after the cut-off, the pressure called t' will be, according to Poisson,

$t' = t\left(\frac{l}{l+z}\right)^{\gamma}$ and the differential of the work performed will be $= t\left(\frac{l}{l+z}\right)^{\gamma} d\,z$.

The integral of the above is

$\frac{t\,l^{\gamma}}{1-\gamma}(l+z)^{1-\gamma} + \text{C},$ and the condition that this shall be zero, when z is zero, gives

$\text{C} = -\frac{t\,l^{\gamma}}{1-\gamma}\,l^{1-\gamma}$ and hence the work done after cut-off is $= \frac{t\,l^{\gamma}}{1-\gamma}\left((l+z)^{1-\gamma} - l^{1-\gamma}\right)$ which may be written

$$\frac{t\,l^{\gamma}}{\gamma-1}\left(\frac{1}{l^{\gamma-1}} - \frac{1}{(l+z)^{\gamma-1}}\right) \qquad (1)$$

In the particular case under consideration, the entire stroke, or $l + z$, is considered as unity.

With this modification, the expression becomes by reduction $\frac{t}{\gamma-1}(l-l^{\gamma})$ for the work done during expansion on a unit of surface of the piston.

The area of the piston being a, the total work done *during the stroke*, or, in this case, the mean pressure (with external atmospheric resistance deducted) will be expressed thus,

$$\text{P}' = a\,l\,t + \frac{a\,t}{\gamma-1}\left(l - l^{\gamma}\right) - 15\,a$$

By a similar course of analysis, the work of *compression* in the supply cylinder will be represented by the expression,

$$\frac{15}{\gamma-1}(1-z)^{1-\gamma} - \frac{15}{\gamma-1}$$

calling d' the density in which the air is compressed, z must be put $= 1 - \frac{1}{d'}$. Substitutions and reductions made, the expression becomes $\frac{15}{\gamma-1}\left(d'^{\,\gamma-1} - 1\right)$ and the total resistance in the supply cylinder during the stroke (the action of the external atmosphere deducted) will be

$$\text{(A)} \qquad p' = a\,m\,t\,\frac{1}{d'} + a\,m\,\frac{15}{\gamma-1}\left(d'^{\,\gamma-1} - 1\right) - 15\,a\,m$$

The effective or differential mean pressure will therefore be

$$\text{(2)}\ \text{P}' - p' = a\left[l\,t + \frac{t}{\gamma-1}(l - l^{\gamma}) - \frac{m\,t}{d'} - \frac{15\,m}{\gamma-1}\left(d'^{\,\gamma-1} - 1\right) - 15\,(1-m)\right]$$

Calling, as before, the density of the air in the working cylinder at the moment of cut-off d; the temperature of said air *above* 60° T, and the atmospheric pressure and temperature 15 lbs. and 60°, then

$$t = 15\,d\left(1 + \frac{\text{T}}{519}\right) = 15\,d\,\text{A}\left(\text{putting } 1 + \frac{\text{T}}{515} = \text{A}\right)$$

but $d = \frac{m}{l}$ hence $t = 15\,\frac{m}{l}\,\text{A}$, and $d' = \left(\frac{t}{15}\right)^{\frac{1}{\gamma}}$

(See "Theoretical Investigation," &c., for the determination of these values.)

Substituting these values of t and d, and d', in formula (2), we should have $\text{P}' - p'$ in terms of the length of stroke up to cut-off l; that is, in terms of the same element I made use of in the formulas in the July paper. But instead of this, I prefer to eliminate l, by means of its value,

$$l = 15\,\frac{m}{t}\,\text{A}.$$

Making these substitutions, and the necessary reductions, we have

$$\text{(3)}\quad \text{P}' - p' = \frac{15\,a\,m}{\gamma-1}\left\{\gamma\left[\text{A} - \left(\frac{t}{15}\right)^{1-\frac{1}{\gamma}}\right] - \text{A}^{\gamma}\left(\frac{15m}{t}\right)^{\gamma-1} + \frac{1-\gamma\,(1-m)}{m}\right\}$$

as the formula for the mean working pressure of the Ericsson engine, in terms of the pressure t of air in the reservoir.

Mr. Ericsson assumes t at 12 lbs. above the atmosphere; and I have shown, in my previous paper, that the negative or counteracting pressure at end of stroke with such a pressure is so enormous, as to make this an extreme limit.

Most of the computations in the July paper were founded upon a temperature of 440° (or T=380°.)

I gave then my reasons for adopting this temperature; and though I am well satisfied, in my own mind, that for an engine constructed like those of the caloric ship, this is pretty nearly a true limit, it is worth while to see how much a higher degree of heat affects the working pressure; and also to make some estimate of the effect of increased working pressure on the velocity of the piston, and consequent horse power of the engine.

Taking $a = 22,300$ square inches, $m = \frac{2}{3}$, as these elements are in the Ericsson engine, and $t = 27$, I have

For a temperature of . . . 440° $P' - p' = 70,273$ lbs.[*]
" " . . . 480 " 79,014 "
" " . . . 500 " 88,487 "
" " . . . 552 " 93,605 " (4)
" " . . . 589 " 102,620 "

The result for 440° corresponds pretty nearly with those obtained by the formulas in my former paper, though it is somewhat less, as it should be; 480° is the temperature more ordinarily assumed; 552° is the temperature deduced (as far as any thing can be deduced) from Mr. Ericsson's computations of June, using his own figures, (120° + 432°), as the nearest approach to an intimation on his part of the temperature *he* expected to be able to carry; and, lastly, 589° is the *real* temperature required to fill his working cylinder to ¾ths, as *he* fixes his cut-off in that computation.

Believing the two last temperatures to be entirely impracticable, I merely place them here, so that the working pressure deduced therefrom may be known.

In my previous computations, the velocity of the piston has been uniformly assumed as 120 feet or 10 revolutions per minute. Mr. Ericsson objected to this velocity, and assumed 200 feet per minute in his computation.

The velocity is a function of other elements, and cannot be arbitrarily assumed for an engine with all its attachments fixed and resistances computable, even if (as he has not demonstrated) the air can be heated in sufficient quantity for any given velocity; but, presuming the heated air to be thus supplied, the velocity certainly will increase according to certain laws, not easily expressed, as the working pressure increases.

With an 8 lb. pressure, the number of turns of the wheels in trial trips (See Professor Norton on the caloric engine, *Silliman's Journal*, for May) is given at 9 to 9¼ per minute.

With an 8 lb. pressure (or $t = 23$) and temperature of 440° (or T = 380°), the reported temperature, my formula gives, $P' - p' =$ 55,865; or if the cut-off is assumed at ⅔d, as the report gives it (through leakage), I get $P' - p' = 40,225$.[†]

Assuming, therefore, 40,225 lbs. pressure to be capable of turning the wheels of the Ericsson at the rate of 9 turns per minute, the number of turns for a higher pressure may be approximately, though not very accurately computed.

The resistance of the ship is usually assumed to be proportioned to the square of the velocity with which she moves through the water, and the static pressure on the paddles will therefore increase in the same ratio, which is, likewise, nearly in direct proportion to the velocity of the wheels.

If we assume the friction of the engine without load to be ½ lb. per square inch of piston, as stated by Mr. Ericsson, or 11,150 lbs., the other resistances within the engine are usually considered to increase in direct proportion to the *load*, or working pressure, and therefore, likewise, as the square of the velocity.

To obtain a velocity of piston of 200 feet per minute, we have, therefore, the proportion (deducting 11,150 lbs. 40,225 lbs.)

$$(108)^2 : (200)^2 :: 29,075 : 99,700.$$

To this must be added:—first, the constant resistance of friction, 11,150, making 110,850. But I showed, in the previous article, that a leakage of only $\frac{1}{18}$th, took off 13 per cent. from the aggregate working pressure, and the figures above used have been reduced for leakage. Adding 13 per cent. on the aggregate is equal to 15 per cent. on the reduced pressure, which, added to the above, gives 127,480 for the theoretical pressure per formula, necessary to give Mr. Ericsson's velocity of piston.

So high a temperature as 589° gives but 102,620 lbs. pressure. With what propriety can Mr. Ericsson then assume for his engine a velocity of piston of 200 feet per second? That the pistons of marine steam-engines travel at a much higher rate is no argument, for those engines can develope the required pressure.

For a temperature of 552°, the mean working pressure is 93,605 lbs., or with effect of leakage of $\frac{1}{18}$th introduced (as per formula shortly to be given) 82,523 lbs. Deducting from this the constant for friction, 11,150 lbs., and the velocity of piston will be determined by the proportion $29·075 : 71·370 :: (108)^2 : (169)^2$ or 169 feet per minute.

This velocity of piston, applied to the *aggregate* mean pressure (93,605 lbs.), as deduced from the formula, will give 480 h. p. for each engine, or 960 for the two, instead of 1,313, as calculated by Mr. Ericsson.

I have stated, in my previous paper, that to drive the Ericsson at the speed of the Collins steamers, 1,760 h. p. were necessary; and in thus comparing the *aggregate* h. p. of the caloric and steam-engines, the advantage is altogether in favor of the former; for the aggregate given for the Arctic, from which the above estimate is made, is deduced from the actual observed mean pressure in the cylinders, as determined by an indicator; whereas, for the caloric engine, the pressure is *theoretical*, no deductions being made for the difference of pressure in the supply and working cylinders—or the difference between the pressure of the escaping air of the working cylinder and the external atmosphere. The friction of the steam-engine, with its single 8 foot piston, cannot fall to be less than that of the caloric engine, with its four immense pistons, two of 14 and two of 11 feet. The only resistance of the steam-engine, independently of friction, not common to the other, is that of its air and supply pumps, which may be safely set off against the *leakage*[*] and increased friction of the latter, and yet have a large margin in its favor.

But 552° is a temperature that cannot be maintained in engines of the construction of Mr. Ericsson's. I have discussed this point in my former paper. (See note, p. 154.)

I have introduced it here to show how inadequate the power of the engines are, even with an extreme limit of temperature, and as high a velocity of piston as can be legitimately claimed therefor.

Using a temperature of 500°, which most will consider an extreme limit, and deducing the velocity of piston as before, I get 156 feet, and this, with the mean pressure given by formula, of 83,497 lbs, gives an aggregate for each engine of 395 h. p. or 790 for the two. This is not one-half what the ship requires; and it is an *extreme* expression of the power of the Ericsson engine, no deductions made for any cause whatever.

---

[*] I have in these computations, as in my former paper, taken $\gamma = 1·324$ as the most favorable to Mr. Ericsson, that I was justified in using. It is, more probably, as much as 1·41. See on this subject, p. 221, 2d ed.

[†] Taking this latter figure as the true one, with 9 revolutions, 262 horse power is the power developed by the two engines, on their trial trip.

Professor Norton has computed, by comparison with the Arctic, the h. p. *necessary* to drive the caloric ship at the rate of 7¼ miles (which he considers a fair estimate of her actual rate), 264 h. p.; thus agreeing with the result given by my formula within 2 horse power.

[*] *Leakage* has uniformly been one of the paramount evils in all air-engines yet constructed; and that it is and must ever be so in the Ericsson engines, any one acquainted with their construction might easily predict, even if the proof were not furnished in the actual performance (see note to "Theoretical Investigation," &c., p. 156, *Appletons' Journal*, July). In the computations for leakage in this and my former paper, I have assumed a leakage of but 1-18th, which is but half of that experienced on the trial trips.

And there is but one way of increasing the power, and that is by enlarging the engines, either in diameter or length of stroke. Those who think that engines of such extravagant dimensions can compete with the steam-engine, may calculate the additional dimensions required; but are respectfully referred to the *Franklin Journal*, of February, and Professor Norton's article, for an estimate of weight and bulk, and effect upon the draught and velocity of the ship, for such an increase.

I have said that increased power could only be obtained by increased dimensions of engine. On this point, it is well to examine whether the proportion of supply to working cylinder, as fixed by Mr. E., is really the best.

By differentiating the general formula (3), with reference to m as variable, and putting the differential co-efficient equal to zero, I obtain an equation for the value of m, corresponding to the maximum of the form,

$$(5) \qquad \left[A-\left(\frac{t}{15}\right)^{1-\frac{1}{\gamma}}+1\right]m-A^{\gamma}\left(\frac{15}{t}\right)^{\gamma-1}m^{\gamma}=0 \Big\}$$

By substituting in the above equation (5) whatever value of t it is thought proper to use (depending upon the temperature and the cut-off), that value of m which will produce a maximum result will be obtained. For $t = 27$, the tension always assumed by Mr. E., the maximum value of m is almost precisely ¾. (This is for a temperature of 500° or T = 440.)

Inserting this value of m into general formula, we have $P'-p' =$ 86,490 lbs., or but 3,000 lbs. more than given by a ⅔d supply cylinder; an increment not at all sufficient to compensate for the necessity of heating ⅛th more air, or scarcely for the increased weight and friction of the enlarged cylinder. We may, therefore, consider $m =$ ⅔d, as now established by Mr. E., to be about the best proportion, and that no gain of power is to be expected from altering this proportion.

If a higher pressure is assumed, as $t = 30$ lbs. (T, as before, $= 440°$), the maximum requires m to be slightly below $\frac{9}{10}$th, and the resulting value of $P'-p' = 100,800$ lbs.; but the counteracting pressure at end of stroke is so enormous with this arrangement, as to put it out of the question.

Even with t as high as 27 lbs., this counteracting pressure is, as I have shown in my former paper, fully enough to consume the entire power of both the engines.[*]

The arrangement proposed by Professor Barnard is highly ingenious, and if the Ericsson engine were capable of being improved, would be valuable. But what a comment on them is it that, with their cumbrous form and great weight, it requires not four merely, but *six cylinders, to make one engine*, or, I might say more properly, *twelve;* for it will be observed, the whole twelve are required to maintain the uniformity of power necessary, which the Professor expects to obtain.

Mr. Ericsson *claims* (see his article in June number) 1,613 h. p. for his engines—1,760 are necessary to give the speed of the Collins steamers; and Professor B., by his new arrangement, finds some 8 or 900 attainable. But, to obtain this, the counteracting force is carried to its extreme limit.[*]

But it is not admissible for marine engines thus to lose periodically almost all their power—even if it was not otherwise highly objectionable in double engines, to depend upon one to do the task of the other. Should one become disabled, the other would be almost unavailable (a difficulty in no way overcome by the third cylinder).

In double marine-engines, the action is almost *perfectly* equalized; but with them as with single engines, where the power is more unequally applied, it is, with heavy head gales, an important and almost indispensable privilege, to be able to turn the steam on at full stroke, to which there is no analogous quality in the caloric engine. The importance of equal power through the stroke creates the necessity of double marine-engines for long ocean voyages.[†]

No important gain can, therefore, be obtained by enlarging supply cylinder. The theoretical increase indicated by enlarging m with t is practically unattainable.

As leakage can never be wholly overcome, in the caloric engine, it is desirable to introduce its effects in the general formula. It would be difficult, or at least very complicated, to form an analytical expression for the effect of leakage, considered as acting during the whole stroke. But, considering the whole leakage to be concentrated in that portion of the stroke before the cut-off, it is quite simple. Calling the leakage q, the value of t will be found

$$15\frac{m}{l}A(1-q) \text{ instead of } 15\frac{m}{l}A.^{\ddagger}$$

Putting $1-q = n$, and substituting this value of t in equation (1), the expression for mean pressure becomes

$$(6) \qquad P'-p'=\frac{15\,a\,m}{\gamma-1}\left\{\gamma\left[nA-\left(\frac{t}{15}\right)^{1-\frac{1}{\gamma}}\right]-(nA)^{\gamma}\left(\frac{15\,m}{t}\right)^{\gamma-1}+\frac{1-\gamma(1-m)}{m}\right\}$$

Making $q = \frac{1}{12}$ the values of $P'-p'$ become (other elements the same as for computations given before)

(7) For temperature of . . . 500° $P'-p' =$ 71,787
" . . . 572 " 82,593
" . . . 599 " 92,985

By comparing these results with those of page 318, 1st col., the effects of a $\frac{1}{12}$th leakage will be perceived.

Results obtained by this formula correspond with those in former paper, obtained by simply calculating the effects of a leakage on the cut-off.

The equation for maximum effect, in relation to m, will be of the same form as eq. (5.)

$$(8) \qquad \left[nA-\left(\frac{t}{15}\right)^{1-\frac{1}{\gamma}}+1\right]m-(nA)^{\gamma}\left(\frac{15}{t}\right)^{\gamma-1}m^{\gamma}=0$$

For a leakage of $\frac{1}{12}$th, the value of m does not vary materially from that obtained before (¾); but for a leakage of ⅕, $m = \frac{9}{10}$ gives a maximum effect.

For m ¾, and a temperature of 500°, and leakage of $\frac{1}{12}$ $P'-p' =$ 77,276, showing a gain of above 5,500 lbs. over the value (6), for a ⅔d supply.

I will close this paper with a few words on the comparative economy of heat in the steam-engine and the hot-air engine. I need scarcely say that the crude reasoning applied to the action of the regenerator, in my July article, is founded upon the old theory of the materiality, or, at least, of the *invariableness* of quantity of heat;—the theory upon which Mr. Ericsson and his admirers have planted themselves in their extravagant claims for economy of heat by a regenerator. It was desirable to show, that even on *that* theory an expenditure of heat must necessarily take place—even with a theoretically perfect regenerator—materially greater than that due to the mechanical equivalent of the useful effect produced. But on the modern and now generally adopted theory—a theory which the experiments of Rankine, Joule, Regnault, and others have almost placed beyond a cavil—heat and work are convertible things. If, therefore, we consume a certain quantity of fuel, we may obtain the product in heat alone, or we may obtain it (partially at least) in work, but we cannot obtain both. Whatever is converted into one cannot be resumed in the shape of the other, except by undoing all that has been done.

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[*] Since making the above computations, I have seen an article by Prof. F. A. P. Barnard, in *Silliman's Journal*, in which he proposes to equalize the pressure and remedy the counteracting force, by using a third cylinder. As my theoretical results are independent of this spasmodic action, it would not be necessary to refer to this modification at all, except that the author counts upon the practicability, by its means, of using larger supply cylinders and carrying higher pressures.

I have shown that for $t = 27$ lbs. nothing is to be gained by enlarging the supply cylinder; with $t = 30$ lbs. the supply maximum cylinder would be theoretically 9-10th; but as I have observed above, the counteracting pressure is entirely inadmissible.

[*] It will be shown hereafter, that Mr. E.'s heaters are entirely inadequate to heat the quantity of air furnished by a supply cylinder of ⅔; and *any* enlargement, even if desirable, is out of the question.

[†] But the four working pistons of Mr. E.'s so called double engines, constitutes, in fact, but *one engine*.

[‡] See "Theoretical Investigations," &c., p. 157.

The heat, therefore, in the hot-air engine, as in all thermo-dynamic engines, which has performed work, has ceased to be heat, and is, of course, beyond the reach of the regenerator. In the Ericsson engine, a large proportion of the work performed is uselessly expended in *compressing* (See article of Prof. Barnard on this subject, in *Silliman's Journal*, for September) the air in the supply cylinder, and in overcoming the external atmospheric resistance due to the difference of areas of the working and supply piston.

As *all* the work done, whether useful beyond the engine or not, consumes its proportion of heat, it follows, as a matter of course, that even with the most perfect action of the regenerator, the heat consumed must necessarily exceed the proportion due to the useful effect produced.

But there are far other sources of waste of heat than this. The regenerators cannot cool the escaping air lower than the temperature of the inflowing air, by which they are themselves cooled; and this limiting temperature is the temperature developed in the supply cylinder and reservoir by compression.*

The imperfect action of the regenerators (for which Mr. Ericsson allows 30°) is still another source of loss.

And, again, whatever be the tension of the air in the working cylinder, it will, in escaping into the atmosphere, expand to the tension or pressure of the atmosphere, still further absorbing or consuming heat by this expansion. When the cut-off is used (as it always will be in practice), a portion of this consumption will be converted into work, by expanding within the cylinder.

I shall not attempt to give a general analytical expression for the different proportions of heat, converted into useful work, or otherwise consumed, as, except in the case of an equal supply cylinder, such an expression would be complicated; but shall take a particular case, favorable to the engine, viz., that of a supply cylinder of ¾d, and a high temperature of 500°.

Call this temperature T', the temperature of the external air θ, and the temperature of compression (which will be the temperature of the receiver) θ', assuming $t = 27$.

The total quantity of heat supplied by furnaces and regenerators, to raise the mass of air from θ' to T', under constant pressure, will be $(T'-\theta')\,\gamma$, of which $(T'-\theta')\,(\gamma-1)$ will be consumed in work,† up to the moment of cut-off. From the cut-off to the end of the stroke, the mass will work by expansion, and another portion of heat be converted into work; and on opening the escape-valve, a further expansion will take place, down to atmospheric pressure, by which heat will be still further consumed. As I am now investigating the entire *consumption*, whether useful or not, I will call θ'' the *total fall* of temperature from $t = 27$ to $t = 15$, and this being added to the above $(T'-\theta')\,(\gamma-1) + \theta''$ represents the total consumption. The difference $(T'-\theta'-\theta'')$ between this expression and the total quantity of heat supplied $(T'-\theta')\,\gamma$ will represent the quantity which can be saved by the regenerators.

But as the air cools through this number of degrees under *constant atmospheric pressure* $(T'-\theta'-\theta'')\,\gamma$ will be the actual quantity of heat given up to the regenerators, and the total consumption will be reduced to $(T'-\theta')\,(\gamma-1) + \theta''-(T'-\theta'-\theta'')\,(\gamma-1) = \theta''\gamma$. In the above case, the values of θ' and θ'', calculated from Poisson's formula, will be (nearly) $\theta' = 140°$ $\theta'' = 129°$

From whence $\theta''\gamma$ (or consumption) = . . . 171°
$(T'-\theta'-\theta'')\,\gamma$ (saved by regenerators) = . . 305
$(T'-\theta')\,\gamma$ (total supplied), ... 476

This supposes perfect action of regenerators; but it is proper to make the allowance of 30°, which Mr. Ericsson gives for their imperfection of action, in which case,

The consumption $= (\theta''+30)\,\gamma =$ . . . 219°
Saved by regenerators, $= (T'-\theta'-\theta''-30)\,\gamma$ . . 257
476

Formula (3) gives 83,487 lbs. raised 6 feet, as the useful effect in this case. Call m the mass in lbs. of air heated, and Kv the mech. equiv. of a deg. of heat per unit of mass, and we may ascertain the value of Kv, by taking the expression, see eq. (A), for work done during compression, viz.,—$a\,m\,\frac{15}{\gamma-1}\left(d'^{\,\gamma-1}-1\right)$ putting $a = 22{,}300$ square inches $m = \frac{3}{4}$ and $d' =$ the density (by Poisson's formula) corresponding to a compression from 15 to 27 lbs. The above expression becomes 106,407 lbs., raised 6 feet by 50 units (or lbs.) of air heated 80°*, or 159·6 lbs.† raised 1 foot per lb. heated 1 degree, and

$(\theta''+30)\,\gamma$ M Kv $= 219 \times 50 \times 159{\cdot}6 = 1{,}747{,}620$ lbs. raised 1 ft.
While the actual effect $= 83{,}487 \times 6 = 500{,}922$ " "

Which gives the work done to the mechanical equivalent of the heat consumed as 1 : 3½.

In case T′ had been but 410°, the result would have been
$(\theta''+30)\,\gamma$ M Kv‡ = . . . 1,596,000 lbs. raised 1 ft.
Actual effect per formula = . . 421,658 " "
And the ratio of effect of heat consumed, or 1 : 3·8

To compare these theoretical results with those of the marine steam-engine, take the case of the Arctic, whose performance, consumption of fuel, evaporation, and mechanical effect produced, are given in great detail in the *Franklin Journal*, for January, and *Appletons' Mag.*, for March.

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* In practice, this temperature may be somewhat reduced by radiation from the reservoir; but it is easy to show that this does not in any material way influence the final result.

† This quantity of heat disappears, and becomes insensible to the thermometer, and according to the now received theory, is *converted into work*.

* 80 degrees is the temperature developed by the above compression, and is considered the thermal equivalent of the work of compression.

† This value of Kv is based on a value of $\gamma = 1{\cdot}324$. It is incorrect, but used because the power of the engine was obtained from the same value, and the final result errs in favor of the engine.

‡ The above determinations are for a particular case; but for any other case, T′ being the temperature Fah. used in the working cylinder, and t the tension of reservoir (60° being the weather temperature), we shall have

$$\theta' = (491+28)\left(\frac{t}{15}\right)^{\frac{\gamma-1}{\gamma}} - 491 + 32°$$

$$\theta'' = T'-32°-[\,491+(T'-32°)\,]\left(\frac{15}{t}\right)^{\frac{\gamma-1}{\gamma}} + 491°$$

from whence the consumption of heat can be calculated, while the useful effect must be determined by my general formula (3).

Call M the mass (in lbs.) of air furnished by supply cylinder, Kv the mechanical equivalent of heating 1 lb. of air 1° under constant volume, and

$$(\theta''+30)\,\gamma\ \mathrm{M}\ \mathrm{K}v$$

will represent the work done to the heat consumed, which, compared to the actual work, will show the ratio of effect produced to that due to heat consumed.

The consumption of fuel is 3½ lbs. anthracite per horse power per hour, evap. 7·6 lb. water per lb. of coal, from a temperature of 110°[*], or 26·6 lb. water per h. p. per hour. As it requires 1092° of heat to evaporate from 110°, 1 lb. of water, 26·6 × 1092 = 29047° or units of heat exert a mechanical effect of 1 horse power for 1 hour = 33,000 × 60 = 1,980,000 lbs. raised 1 foot = 68·27 lbs. per degree of heat applied to a lb. of water. Assuming the mechanical equivalent of so much heat as would heat 1 lb. of water 1 degree, as given by Rankine, 772 lbs., the useful effect is to the heat consumed as 1 : 11·3. Comparing this result with that obtained for the air-engine, we have 3½ : 11·3, or 1 : 3·23,[†] as the relative power of the steam and air-engine from the same amount of heat.

This is, however, an unfair representation for the steam-engine: a theoretical result, in which no allowance is made for loss of heat by leakage, or radiation, is compared to the average *actual* performance of a marine steam-engine. And as I shall have occasion to show hereafter, the value of γ for air is probably too low, giving too high a mechanical equivalent for air.

In actual performance, the Ericsson engine has realized an economy of fuel of (at highest estimate) 1 : 1·36 (see Prof. Norton's article) over the steam-engine. Now (the temperature being the same) the mere carrying of *low pressure* affects, in a very trifling degree, the ratio of work performed to heat consumed (being 1 : 3·8 for $t = 27$ and $T' = 440°$, and 1 : 3·7 for $t = 23$). The leakage and radiation alone were effective sources of loss, and it must either be conceded that one-half of the power due to the heat consumed was lost through these causes, or that my theoretical ratio for steam and air of 1 : 3·23 is far too favorable to air.[‡]

The accuracy of results given by formula (3), for working pressure of the hot-air engine will depend much upon the value assumed for γ. The larger this quantity is, the less will be the values of $P'-p'$. For this reason, I adopted the lowest value I was justified in doing—one determined by myself from the temperature developed by compression of air, as stated by Mr. Petrié.

But Mr. Petrié's experiments were made apparently with no eye to this determination.

Poisson gives two values, the mean of which is 1·36, from his own experiments, and gives also 1·421, as determined by Dulong, for air perfectly dry, and 1·406 as determined by observation of the velocity of sound, and inclines to the largest value of all, 1·421.

But there are other considerations in favor of a higher value than I have used, which are almost conclusive.

The value of the mechanical equivalent of heat applied to air, and that of γ, are mutually functions of each other, and any accurate experimental determination of the one will equally determine the other. Very elaborate experiments have been made by Joule, Rankine, and others, as to this latter quantity, and from the results of those experiments, the value of γ can be deduced.

Returning to expression (1) for work done by an expanding volume of air,

$$\frac{t\,l^{\gamma}}{\gamma-1}\left(\frac{1}{l^{\gamma-1}}-\frac{1}{(l+\varepsilon)^{\gamma-1}}\right)$$

when ε or the expansion is infinite, this will give us the total amount of labor, a given volume having a length l, and pressure t, is capable of doing.

Making $\varepsilon = \infty$, the second term disappears, and the expression reduces itself to

$$\frac{t\,l}{\gamma-1}$$

This amount is directly proportional to the pressure or tension t. If 519° of heat are added to the volume, its temperature being at 60°, t will be doubled, and the increment will be what is due to 519°.

Putting $t = 14·725$ = the mean atmospheric pressure, and a the surface upon which it operates, M the mass, and K p the mechanical equivalent of the heat required to raise 1 lb. of air 1 degree under constant *pressure*, we shall have

$$\mathrm{M}\,\frac{\mathrm{K}\,p^{*}}{\gamma} = \frac{14·725\;a\,l}{519\,(\gamma-1)}$$

from whence we have $\gamma = \dfrac{519\ \mathrm{M\,K}\,p}{519\ \mathrm{M\,K}\,p - 14·725\;a\,l}$

Joule has determined the value of K p at 184 lbs.; calling a = 144 square inches, $l = 1$ foot, M = weight of cubic foot of air at 60° = ·07625 lbs., and substituting these values, we have

$$\gamma = 1·4108,$$

corresponding very nearly to the value of γ, fixed by Rankine himself, 1·4094, and being a mean between the two higher results quoted by Poisson.

There can be no doubt that this is extremely near the true value. This value would materially cut down the figures given, equations (4), for $P'-p'$. For example, for a temperature $T' = 500°$ $m = \frac{2}{3}$, $t = 27$, and $\gamma = 1·408$, $P'-p'$ becomes 77,260, instead of 83,487; a difference of 8 per cent. on the smaller number.

I have, however, chosen to retain $\gamma = 1·324$, as a value giving results favorable to the engine.

Conclusions.

As legitimate deductions from the theoretical investigations contained in this and preceding papers, I present the following:—

1st. The power of the hot-air engine of Mr. Ericsson's invention cannot be materially increased by any modification of arrangement, or proportion of its parts.

2d. That by allowing so high a degree of heat as 552°, and as high a velocity of piston as can be conceded, these engines will develope a power scarcely exceeding one-half that required to drive the ship at the speed of the Arctic.

3d. That the only method of increasing power is to increase the already extravagant dimensions.

4th. That as a marine-engine it is vastly inferior to the steam-engine. 1st, in being single acting; 2d, in the necessity in *all cases* of combining four of these single acting engines to obtain uniformity of action, which, after all, scarcely exceeds that of a *single* steam-engine.

5th. That in economy of fuel there is some advantage in favor of the air-engine, not at all approaching, however, the claims of the inventor, and which, in theory, cannot exceed 1 : 3·23; and which, in practice, has not thus far exceeded 1 : 1·36; and that this meagre experimental result is *not* accounted for by the low pressure used, and very inadequately by the leakage.

6th. That the results given by my computations, with $\gamma = 1·324$, are probably in favor of the engine, by as much as 8 per cent.

[The remainder of Maj. Barnard's paper is devoted to Mr. Ericsson's objection to his theoretical results, and is unavoidably postponed to the November number.]

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[*] The feed water, in restoring heat, serves the same purpose, as far as it goes, as the regenerator in the air-engine.

[†] Prof. Barnard has made the ratio to be 1 : 4·556, but has made no allowance for imperfect action of regenerators, and has used a lower value of steam than I have deduced from the Arctic.

[‡] That this ratio should exist, it is necessary to assume that the heat carried away by the draught, lost by radiation, &c., bears no greater proportion to the total consumption of fuel in the air-engine than in the steam-engine. The radiation, owing to the high intensity of heat in the air, and the great extent of cylinder surfaces, will be necessarily greater; and from the imperfect manner in which Mr. E.'s *heaters* can cool the products of combustion, as compared with the tubes and flues of a marine boiler, there can be no doubt that here Mr. E.'s air-engine labors under a great disadvantage; and that the disproportion between the theory and practical result, as given above, is mainly due to this.

[*] K p is divided by γ, in order to reduce it to K v, or *constant volume*, to which the analysis applies.

[For Appletons' Mechanics' Magazine.]

On Sand-Core Moulding, Blackening, &c.

By James Larkin.

Amongst the great variety of work denominated green-sand moulding, much and varied contrivance is displayed in the structure of the moulds. In particular, the management of cores is a matter of very considerable importance, and the malformation of them is a prolific source of failure in the production of sound castings.

Cores are especially useful for forming vacancies in castings. Their forms may be long and proportionably small in diameter, or winding, and otherwise intricate; and seeing that they are necessarily surrounded by the metal, when cast, they ought to have as much as may be the qualities of firmness of substance and openness of pores. Cores are commonly composed of rock-sand and sea-sand. The former having a proportion of clay in its composition, to which it owes its powerful cohesiveness, when dried, serves very well for short cores, that rest on the green sand at both ends, as open communication with it is thus afforded for the free escape of the air in the interstices of the cores.

But when rock-sand is used for cores of a considerable length (which, of course, are surrounded on all sides by the metal, except the small imbedded portions at the extremities, by which alone the air can escape), it requires to be moderated by the admixture of free-sand, as a counteractant to the clay. The clay communicates the necessary cohesiveness to the material of the core; the sand, on the contrary, loose and open, renders it less binding and more porous. Free-sand alone is also employed in the construction of confined cores, that they may afterwards be easily extracted, as the sand has naturally no power of cohesion.

Wanting cohesiveness, it must be tempered to a proper consistency, by the addition of clay and water, yeast, flour, or the refuse of pease-meal, used for light flat moulding purposes. In the use of the latter materials, it must be accurately proportioned to the sand with which it is mixed. The clay-water is, in ordinary cases, made use of as a cement, and the yeast only in very particular circumstances. For large compact masses of core, the common green sand may be used.

The longer cores are stiffened by iron wires and small rods, which are bent, if necessary, to the form of the cores; these rods are dipped in clay-wash, and enveloped in the core in the progress of its formation, and are afterwards extracted from the casting. The cores of considerable length are pierced longitudinally by wires for the "escape of the air;" or in cases where this is impracticable, on account of bends or angles in the core, a piece of string is laid in the sand alongside the stiffening wires, which is afterwards drawn out, when the core is dry, leaving its perforation behind it; with all these precautions, securing the strength of the cores and letting off the air, your castings have every chance of being good and free from blow-holes. When the bearings of cores at the extremities are considered unfit for steadying them, they are further sustained by staples stuck into the sand at several places in their length, and projecting above it just as much as the thickness of metal, the core is placed upon them, and sustained steadily in its place; the staples are, of course, buried in the casting, and the projecting points outside cut off in the course of dressing it; chaplets are used to bear up cores having plain surfaces. Another set of chaplets, or staples, are placed in the cope, and well secured at the back, when the flask is closed, firmly fixed, and in contact with the upper half of the core, it is thus prevented from floating off its seat, when immersed in the fluid metal, and prevented from springing. This is a matter of greater moment than the mere sustaining of the core from below, as will be apparent on considering the great difference of specific gravities of sand, dry loam, and iron or brass.

In this case, the upward effective pressure of the fluid metal upon the core is proportional to the difference of their specific gravities, which, being so much in favor of metal, the pressure upwards, sustained by the chaplets, cannot be much less than the weight of a body of metal of the same bulk as the core; for the support of which they are destined, in brass founding particularly, great care should be taken that the staples and chaplets are sufficiently strong; should they be too slightly made, they will bend or melt before the hot metal, and prove entirely useless. *This is too often neglected.*

Ordinary blackwash for cores consists of oak charcoal, powdered, and a little clay, diluted with horse-dung water. Blackening for moulds is often composed of finely-ground plumbago, mixed with a little charcoal, the whole diluted with a solution of the soluble parts of horse dung. This is frequently mixed with pease-meal, or other meal, glue, and extracts from the refuse of tanneries; but all these compositions are more or less too close, and cause a dull surface to the cast; the first is the best, if applied not too much diluted. Blackening, or a coating of carbon, will prevent the burning of the sand, and consequent roughness of the casting, as it fills the pores of the sand; a little plumbago mixed with it makes it more refractory still, and is very desirable where a great body of metal surrounds a small core.

One part of clay mixed with nine parts of free-sand, or any other pure sand, is considered sufficiently strong for core sands; still these properties depend very much on the nature of the sand and the adhesiveness of the clay, and also what kind of cores are to be made from it—large and complicated cores being made stronger than small ones.

The various kinds of good moulding-sand employed in foundries for casting iron or brass, have been found to be of an almost uniform chemical composition, varying in grain or the aggregate form only. It contains between 93 and 96 parts silex, or grains of sand, and from 3 to 6 parts of clay, and a little oxide of iron in each 100 parts. Moulding-sand, which contains lime, magnesia, and other oxides of metal, is not applicable, particularly, for the casting of iron or brass; such sand is generally either too weak or too close—will not stand or retain its form, or it will cause the metal to boil through its closeness.

In practice, different kinds of castings require different kinds of sand for the purpose of moulding, which will furnish the subject for another article.

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Panama Railroad.

The Isthmus of Panama, the route to regions, compared with whose riches, the fabled wealth of the Indias were *but* fables, is the most attractive spot in the physical geography of the world. As a necessary consequence, the enterprises in progress to facilitate the transportation both of passengers and merchandise over it, possess an interest equal to that attached to the route itself, and we are certain that nothing can be more interesting to our readers than a brief account of the only railroad by which its passage is yet attempted.

The Panama railroad commences at the port of *Aspinwall*, situated upon the little island of Manzanilla, lying at the mouth of Navy Bay, and distant about 6 miles east of *Chagres* river. By the route adopted for the line of the road, the distance from Navy Bay, on the Atlantic, to Panama on the Pacific side of the Isthmus, is *fifty* miles. The general course of the road from Navy Bay, is slightly east of south, longitude of Aspinwall, being 75 deg. 55 min. west from Greenwich; that of Panama, 75 deg. 31 min. west. At the point of crossing the general direction of the Isthmus is from west to east.

Upon the route adopted for the road, the general surface of the country is level. The road strikes the *Chagres* river about 7 miles after leaving Aspinwall, and follows it to Gorgona, a distance of 30 miles from the former place. Gorgona is but slightly elevated above the Atlantic. The road leaves the river at this place, and commences the ascent of the dividing ridge between the two oceans, which is 275 feet above high water in the Atlantic. At the summit there is to be a cut of 25 feet, which will reduce the elevation obtained by the road to 250 feet. The summit is about equidistant from Gorgona and Panama, or ten miles from each. The elevation upon either side is overcome in this distance. The steepest grade on the Pacific side will be 70 feet for one mile; that on the Atlantic side will not exceed 60 feet. The gauge of the road is 5 feet.

Navy Bay affords an excellent harbor, with sufficient water for the largest ships. The maximum flow of the tide here does not exceed two feet, while at Panama the average flow is from 20 to 25 feet; so that at low tide the water in the Atlantic is some 20 feet higher than in the Pacific, which accounts, we presume, for the greater supposed elevation of the former. At Panama the water is shoal in shore, but a mole may be run out at comparatively small expense to a sufficient depth to float large ships.

The description we have given would lead one to suppose that a road across the Isthmus would be an easy task. It would in the United States, and it would not, under proper management, have been a very difficult one any where. But as it is, it has made a most slow and toilsome progress. A small portion of the road was opened nearly, if not quite, two years since. It was finished to its present terminus, Barbacoas, 24 miles from Aspinwall, something over a year ago, and was to have been completed by the 1st of September next, according to the announcement made when the contract for its construction was made. But in place of such a result, we believe that the road has not advanced a yard since that time. The four years which have elapsed since the road was commenced, have not sufficed to open it for half its length. As the most difficult part of the work is to come, its final completion can only be seen in the dim future. Reasoning from the past, years must elapse before the locomotive will cross the Isthmus.

The company have received some serious checks which have prevented them from making much progress during the *dry* season just closed. At Barbacoas the Chagres river is to be crossed. The bridge over it was to have been constructed during the dry season. The wood-work for the bridge had been prepared in the United States, and had been taken to the spot. Two successive attempts have been made to throw the spans across, both of which failed from the effect of two sudden and unexpected freshets. At the time of the last disaster, a portion of the bridge had been nearly completed. This was swept away, and the timbers carried down the stream. Some of them were recovered, but in so damaged a state, as to render it necessary to order anew a portion of them from the United States, and all attempts to reconstruct the bridge must be postponed until the commencement of the dry season some six months hence.

It is certainly much to be regretted that the completion of a road of such importance to the commerce of the whole world should be so indefinitely postponed. One great mistake has been in attempting to employ *white* laborers only, instead of *natives*, or persons accustomed to the climate. Men from the States cannot be profitably employed upon the Isthmus. This is now an admitted fact. It costs a very large sum to get them there, and to maintain them. After working a month or two, they give out, and become a charge upon the company, by whom they must be sent to their homes. This is the principal reason why the road has been prosecuted with so little efficiency. With the labor employed, it has been found impossible to make any safe calculation as to the future. With a native force, drawn from the neighboring States, the work would have progressed slowly to be sure, but steadily. Native laborers can be had for a few shillings a day, including their board, and the moment they quit the service of the company, the latter are freed from all responsibility in reference to them. It is to be hoped that the mistake of the past will lead this company to a wiser course for the future.—*R. R. Journal.*

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[From Correspondence of American Journal of Science.]

Over-heated Steam applied to the Carbonizing of Wood.

For several years past, over-heated steam has been used in numerous industrial operations, and we may say generally that it may be employed in all processes in which a temperature between 100° and 500° C. is required. Among these processes are the extraction of wood-spirit, the continuous baking of bread, the preparation of sea-biscuit, the drying of wood, the preservation of meats, the extraction of volatile substances insoluble in water, the purification of fatty acids, by MM. Leplay and Dubrunfaut, the extraction of the mercury from the residues of zinc amalgam, by M. Violette, and finally the carbonizing of wood by the same chemist.

M. Violette is a member of the Commission on Powder and Saltpetre, and in this situation, he has turned his attention to the ingredients of powder, the manufacture of which still admits of much improvement. The charcoal employed in this manufacture is of a quality intermediate between wood and ordinary charcoal; it is called red charcoal (*charbon roux*), and is produced at 300° C.; at a higher temperature it becomes black charcoal, and at a lower, the carbonization is incomplete.

By the old process of heating in closed cylinders, 10,000 kilogrammes of wood furnished 2000 kil. of black charcoal, and 1300 of red. The new process with steam yields a better article in large quantity, for 10,000 kil. of wood give 4000. The wood immersed in the vapor is readily carbonized, and as it is easy to regulate the temperature of the vapor, charcoal may be obtained of a constant and uniform character. It is some years since that over-heated steam was first adopted in this process by M. Violette, and now the red charcoal, before employed only for the finest powder, is in general use for the cheaper kinds, so simple and certain is its preparation by means of steam.

M. Violette communicates now to the Academy some new results. He shows that the change to charcoal takes place differently with different woods, and that the products of the same temperature differ in elementary constitution. Exposed to moist air, the charcoals absorb more water, the lower the temperature to which they were exposed, and the inverse is true of their power of conducting heat or electricity. Charcoal made at 1500° C. conducts much better than the charcoal of gas retorts, and serves perfectly for electric illumination. The density increases in the same proportion. When lighted, charcoals remain ignited for a time, which decreases as the temperature of carbonization increases. The charcoal made at 250° C. burns more easily and longer; that made between 1000° and 1500° C. will not ignite or burn.

The most inflammable of all charcoals is that of an Agaricus. It takes fire spontaneously at 300° C. Other charcoals, prepared at the temperature 300° C., take fire in air spontaneously between 360° and 380°, according to the wood that has afforded them, the charcoals of the lighter woods burning the most readily.

When charcoals are mixed with sulphur, they inflame at a temperature much below that required when alone; the mixture of the two prepared between 150° and 400° C. is wholly consumed at 250° C. On the contrary, when the charcoal employed has been prepared at 1000° or 1500° C., only the sulphur burns.

To decompose saltpetre, the charcoals require a higher temperature; a heat of 400° C. is needed for the charcoals prepared between 150° and 432°, and a red heat for those made between 1000° and 1500°

Sulphur decomposes saltpetre at a higher temperature than charcoal requires, viz., at 432°. The sulphur alone inflames in common air at 250° C., and not at 150° as stated in treatises on chemistry.

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Sugar from Molasses.

The manufacture of beet sugar has for some years been largely carried on in France. In ten years, the production has doubled, notwithstanding the successive duties which have been laid—duties of an excessive character, since 100 kilogrammes of white loaf sugar pay 59 francs of duties, and sell at 150 francs. In 1842, the production of beet-sugar throughout France was about 40 millions kilog., and to-day it is 80 millions. This progress has been owing to improvements each year in the manufacture.

Among these improvements, the most important is that called the *barytic*, introduced by MM. Leplay and Dubrunfaut, and which enables them to obtain 50 p. c. of the crystallizable sugar obtained in the molasses. It is well known that for a long time this molasses was of little value. Its sugar was supposed to be wholly uncrystallizable, and its only use was for making alcohol by fermentation, for which purpose large distilleries had been constructed. In an establishment of this kind, directed by M. Leplay, 12,000 kilogrammes of the beet molasses were consumed per day, in making alcohol of 94 p. c., which was wholly used in the manufacture of fine liquors.

M. Leplay and M. Dubrunfaut were the first to recognize that the sugar in the molasses was a sugar perfectly crystallizable, and having all the characters of ordinary sugar; and that to crystallize it, it was only necessary to separate the interfering foreign substances, by operating on the juice of the beet which furnishes the molasses. The solution of the problem was one of great importance, since the amount of molasses annually produced in France, was 40 millions kilogrammes, containing more than half its weight of sugar.

Their process, as I have studied it for some years at the establishment of La Villette, near Paris, is as follows. It is based on the insoluble compound, which sugar forms with baryta. When a boiling solution of caustic baryta, at 30° Baumé, is poured into the ordinary molasses, the substances contained immediately solidify into a porous crystalline mass, insoluble in water, and admitting therefore of thorough washing.

After being thus purified, the saccharate of baryta is white, and has the appearance of a "*bouillie épaisse;*" it is exposed to a current of carbonic acid, which takes up the baryta and sets the sugar at liberty. This operation is carried on in large vats of wood, 80 to 100 hectoliters in size, into which strong pumps, worked by steam, inject carbonic acid obtained by the calcination of carbonate of lime in lime furnaces.

While the reaction of the carbonic acid is going on, it is observed that the "*bouillie*" of saccharate, before very thick, gradually liquefies, and when complete, the whole is a solution of sugar containing carbonate of baryta in suspension.

To separate the carbonate, the mixture is put into sacs made of cotton fabric, through which the syrup filters clear, while the carbonate is retained. These sacs, after draining thoroughly, are pressed lightly in the screw-press, and then subjected to heavy hydraulic pressure, in order to extract the syrup from the carbonate. This syrup thus obtained, marks 18° to 22° Baumé; it is white, of agreeable taste, and holds in solution some traces of the carbonate and bicarbonate of baryta, which may be removed by means of a sufficient quantity of plaster, or of sulphate of alumine. Finally, it is clarified by means of dried blood; it is skimmed and filtered, and boiled down like a syrup for the refinery, after which it is put into forms for crystallizing. We thus obtain, at once, sugar equal in quality to the finest sugars of commerce.

With regard to the residue of this process—the carbonate of baryta, saline substances contained in the molasses, quicklime proceeding from the calcination of the limestone, etc., I have learned the following facts. The carbonate of baryta may be used an indefinite number of times; it is rendered caustic anew after each operation, by mixing it with charcoal and heating it, and so it serves again. The loss of the baryta, which is unavoidable, is resupplied from sulphuret of barium, which M. Leplay prepares by calcining sulphate of baryta with 45 p. c. of charcoal, in a reverberatory furnace, and which he would prepare more advantageously still, if he would apply the process suggested by Gibbs, which consists in reducing the sulphate by the gas of the refinery. The sulphuret of barium possesses equally the property of precipitating the sugar, only there are two equivalents of sulphur, when one of oxygen would suffice. In fact, this last case gives,

$$\text{Sugar} + B^aO + HO = \text{saccharate of } B^aO + HO,$$

whilst the sulphuret affords,

$$\text{Sugar} + 2SB^a + HO = \text{saccharate of } B^aO,\ SH,\ SB^a.$$

There is hence lost 1 equivalent of sulphuret of barium. To avoid this loss, 1 equivalent of potash or caustic soda, is added to the molasses under trial; and then, on pouring in the sulphuret of barium, all the baryta is precipitated in the state of a saccharate, and the liquid retains the potassium in the state of a sulphydrate.

$$2\ \text{Sugar} + 2\ SB^a + KO + HO = 2\ \text{saccharate of } B^aO + SH,\ SK.$$

The use of caustic potash produces a residue with carbonic acid, like the quicklime, and would be too expensive for the purpose, were it not regenerated with each operation. In fact, the waters after washing are collected in boilers, evaporated, and the product then calcined in a reverberatory furnace, with some chalk or lime, and fused. The fused substance is cooled, broken up, lixiviated, rendered caustic by means of lime, and the leyes are concentrated as in the manufacture of soda. The potash is thus obtained for a new precipitation of the saccharate.

In this operation, they obtain not only the potash added in the process, but also the potash and soda which existed primarily in the juice of the beet, and which, by accumulation in the molasses, amounts to about 10 per cent.

In this manner, MM. Leplay and Dubrunfaut have succeeded in isolating, economically, the sugar of beet molasses. But is this process applicable to the extraction of cane sugar? Yes, on one condition; that is, if the manufacture of cane sugar can be so conducted as to give molasses free from uncrystallizable sugar. For MM. Leplay and Dubrunfaut have shown that for 60 to 70 p. c. of sugar in the molasses, there are 30 p. c. of uncrystallizable sugar, which is a result of the method of manufacture, and not preexistent in the juice of the cane.

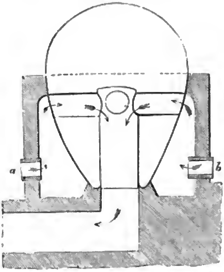
There exists, then, great differences between the manufacture of beet-sugar and cane-sugar; in the former, the molasses contains no altered sugar, and in the latter there is a large quantity of altered sugar.—*Silliman's Journal.*

[From the London Artisan.]

The Egg-Shaped Vertical Steam-boiler.

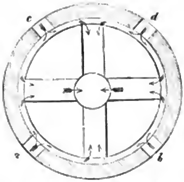
This boiler is known as the "upright egg-boiler," and is much used in Staffordshire, and, I believe, at iron-works in other parts also, from the circumstance of its being so well adapted to be worked by means of the waste heats of the puddling furnaces. For this purpose, it was no doubt originally contrived, but by whom I am unable to say, although the name of its inventor ought to be recorded. It is not easy to conceive a form of boiler more suitable for such an arrangement, especially where high-pressure steam is required.

Fig. 1.



The first boilers of this shape which attracted my attention were at Messrs. Thorneycroft's Shrubbery Iron-Works, where it was very conclusively established that two of them, each about 9 feet diameter and 18 high, made sufficient steam to work at about 80 horse power, entirely from the spare heat or heated gases and smoke proceeding from four puddling furnaces (two to each boiler), which heat had previously gone wholly to waste.

Fig. 2.



In cases where a simpler and less expensive form than that of the present multitubular boiler is required, and at the same time not to occupy a greater horizontal area for an equal amount of power, I have little hesitation in recommending it as a strong and safe kind of boiler, and quite as economical as any, if not more so, for the quantity of heating surface or amount of iron employed.

From some estimates of the consumption of fuel by Messrs. Thorneycroft's engine (a 48-inch cylinder), when worked by boilers of the ordinary horizontal construction, there is every reason to believe that a considerable gain may be made by adopting this construction of boiler generally, for ordinary stationary or manufacturing purposes. I have little doubt that its great economy arises, in a great measure, from the vertical inside flue, the whole of the internal surface of which may be considered as effective in generating steam, in place of the upper half only of the common horizontal flue. And this beneficial efficiency, it is probable, may be further increased, if the lower end of the inside flue was made a few inches wider than the top, thus giving a better position for the generating surface.

Yours, respectfully,
ROBERT ARMSTRONG.

16 Anderson's-Buildings, City-road.

NOTE.—A, B, C, D, in the plan show the places, with respect to the inside flues, at which the hot air or flame is discharged from the puddling furnaces.

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Analysis of the Gases from the Furnaces of Locomotives.

[From a Necrological of M. EBELMEN. By M. SAUVAGE,
Ingeniéur-en-Chef des Mines.]

EBELMEN, with myself as coadjutor, undertook a series of experiments, the object of which was the analysis of the gases issuing from the furnace of the locomotive engine. The results obtained from a considerable number of analyses prove the possibility of establishing a definite theory of this important class of furnaces, which have hitherto been constructed upon notions often contradictory. We have quite clearly proved that these furnaces are much more perfect than they are generally believed to be, and that the combustion is much more complete in the furnace of a locomotive than in that of any fixed engine.

The experiments were made on each of the three types of engine used on the Lyons Railway, viz.:

Passenger engine—not coupled.
Mixed traffic engine—4-wheel, coupled.
Goods engine—6-wheel, coupled.

The composition and nature of the gases varies, necessarily, with the quantity of air which passes through the fire; and this quantity depends, as we know, on the tension of the steam at the escape or blast-pipe.

The proportion of carbonic acid gas contained in the gases of the locomotive is greater than is contained in the gases from ordinary fixed-engine furnaces; whilst the proportion of free oxygen corresponding to the excess of air in the draught is *less* from the locomotive furnace; a result clearly proving that there is a greater useful effect obtained from the fuel.

In the experiments on the passenger engines, and on the mixed traffic engines, the proportion of carbonic acid rose from 12·42 to 18·49 per cent. of the volume of gas, without there being any production of carbonic oxide. The higher percentage represents a result approximating very remarkably to the number 20·80, which represents the proportion of carbonic acid in the case of combustion *theoretically perfect*, or in which *all the oxygen* would be converted into carbonic acid.

The combustion in passenger engines is almost perfect, and in the mixed engine, provided the fire is attended to by an experienced stoker, it is nearly as good. These furnaces produce little or no carbonic oxide; the proportion of this gas rarely exceeds 2 per cent.

The goods engines, the grates of which are often charged with a great depth of coke, produce a greater amount of carbonic oxide. The quantity rose as high as 7·58 per cent., when the fire was 40 inches deep.

The composition of the gas varied according to the range of tube from which it was collected. It would certainly be possible to adopt arrangements which would permit of this carbonic oxide being usefully burnt, and thus improve the useful effect of the fuel in these engines.

During the stoppages of locomotives, or after the shutting of the regulator, the gases have a larger proportion still of carbonic oxide. It gets as high as 12 per cent. of the volume.

These results are quite in accordance with practical experience in reference to the consumption of fuel in these different engines. They indicate a limit of the depth of fire which it is wrong to exceed, and also what amount of economy can be effected by the intelligent employment of expansion and variable blast-pipes, according to the depth of the fuel in the fire.

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[From the London Artisan.]

The Retrograde Power of the Screw.

EXPERIENCE, that great demonstrator of fact, has again given to the nautical world a *practical* lesson in the instance of the screw, which, it is to be hoped, will prove to its advantage. Whatever benefit there may be attached to the screw as a propeller, it is now admitted that it cannot be profitably or safely impelled with the same amount of steam power as that given to the paddle-wheels; and the records of the Board of Admiralty will show that, some years previous to its being adopted in the navy, I ventured to give it as my decided opinion, that as then applied for the purpose of propulsion, it could not produce the speed anticipated; but speed is not the object of the Admiralty in adopting the screw, although there were those in the service and out of it, who asserted with confidence that, with the same amount of power, or with less, the screw would beat the paddle-wheel; and the *Great Britain* was supplied with engines of 1000 horse power to sustain this assertion, and so rigged, that her sails were never to be employed to assist the screw, but alone, when the wind was favorable, and strong enough to propel the vessel without it. Under this arrangement, she made several voyages, having changed her screw more than once, with the hope of improving her speed and reducing her unpleasant vibrating motion. When first fitted for sea in 1848, the *Great Britain* was announced as capable of "delivering dispatches in India with upwards of 2000 troops in forty days, and to carry coal enough for a distance of 12,000 miles, consuming 55 tons per day;" but experience has shown that she could not accomplish the distance in double the time, her late return voyage from Australia occupying 88 days, which was considered favorable. Her failure, as a "*full-power*" steamer, has caused her to be reduced to "*an auxiliary of 500 horse power, and to be fitted as a full-rigged clipper sailing ship, with a screw which is expected will remove all vibration*," as stated by advertisements in the *Times*.

She was originally fitted with six masts, with a spread of canvas "covering more than an acre of ground, her plain sails (4943 yards) of double-thread canvas No. 1;" and this, it would appear, was not enough to drag her late three-bladed screw through the water. In her new rig with three masts, her spread of canvas will be about 8500 yards, equal to that of a first-rate 120-gun ship of war; and, to meet the expenses required to navigate her as an auxiliary, instead of a full-power steamer, her saloon cabin charge is 70 guineas and £8 per ton freight for cargo, being double the amount charged for passage and freight in clipper sailing ships, which have made the voyage in 75 days to Australia. This retrograde movement, on the part of the *Great Britain* and other screw vessels, is the result of necessity, it being dangerous to work up to the full power of the engines at sea; thus giving proof that, as now built and fitted, screw vessels cannot be propelled with safety and advantage, with the same amount of power as that given to paddle-wheel vessels intended for ocean purposes, and that they must continue to remain, as a natural consequence, inferior as it respects speed. To a superficial observer, it may appear strange that a screw vessel will not bear the same amount of power as that of the paddle-wheel; but to those who will take the trouble to trace to its proper source the effects produced by the full power given to ocean screw steamers, with the hope of competing with their more appropriate rivals, it will appear unaccountable that it should have been attempted.

The propelling power being applied to the stern of the vessel and submerged, must, as a natural result, tend to raise the stern and depress the head;[*] whereas, if applied midships, or on the fore side of the midship section, it would have an opposite tendency, and the vessel would glide buoyantly and safely over the sea, instead of being buried in it with such a retarding and dangerous influence, as that which has caused this retrograde movement on the part of the screw.

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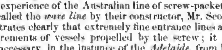
[*] A wrong cause is here assigned, for the tendency of the screw to raise the stern of the vessel. The screw tends to throw the water radially in all directions as well as backward; and meeting with more resistance in throwing it downward than upward, the result is a tendency in the screw to rise toward the surface of the water. In some of the modern forms of screw, however, this radial tendency of the water, and the consequent lift of the stern, is very slight, and in no case is it due to the fact of "the propelling power being applied to the stern and submerged." Abstractly, the circumstance of the propelling force being applied at a low point in the vessel, tends of itself to prevent the rise alluded to; and the fact that it is applied at the stern, rather than at the bow, or amidships, can have no possible influence on the question.—Ed. App. Mech. Mag.

Paddle-wheel steamers, sailing vessels, and canal boats, moving at high rates, rise out of the water at the bow, and will, therefore, admit of finer lines forward than can be given to vessels propelled by a screw; for, in proportion to the fineness of the water-lines forward, the screw vessel becomes depressed at the head, to counteract the lifting efforts of the screw aft, in high velocities; and this, as it must be seen, is no small check to the speed of the vessel.

These dangerous results of ocean experience evidently show the fallacy of expecting to increase the speed of screw vessels, by reducing the displacement of the fore-body below what is absolutely required to meet the lifting tendency of the propeller, and clearly indicates that a greater preponderance should be given to the *immersed* body before the middle of the vessel's length, in vessels of this class, than to those propelled by paddle-wheels; at the same time it is also necessary to increase the emerged after-body at the quarters and around the stern, to prevent the sea from overreaching the vessel when running free or before the wind.

The late experience of the Australian line of screw-packets, built on what is called the *wave line* by their constructor, Mr. Scott Russell, demonstrates clearly that extremely fine entrance lines are fatal to the requirements of vessels propelled by the screw; it having been found necessary, in the instance of the *Adelaide*, from her ungovernable state, to re-stow 200 tons of coals further aft, to lighten her head, after her *trial* trip had been pronounced so favorable. Without commenting on the severe remarks recently made in the House of Commons and in the *Morning Chronicle*, on the defective construction of the *Melbourne* and *Adelaide*, or noticing those of the passengers, who declared it impossible to work the engines up to their full power without endangering the safety of these vessels, I prefer to confine my observations to the causes which prove so dangerous to those and other vessels constructed on the "wave line." There can be no question that fine entrance lines are very desirable where they can be applied; and in one of my former letters I took the opportunity to notice this fact from my personal observations, so far back as 1812; but Mr. Scott Russell, who, I believe, has not had much experience—if any at sea—carries his ideas on this subject beyond the point which late results prove desirable. And here I beg to submit the accompanying sketches from a series of what I call water-tub experiments, made many years before I had an opportunity of giving to naval architecture that attention which I have since ventured to bestow on it.

Fig. 1. Fig. 2.



"To determine the shape in which a body can be passed through a fluid with the least resistance," the French Academy, Colonel Beaufoy, and other distinguished individuals, made a number of experiments, from which I select the figures No. 1 and No. 2, as the most appropriate in the instance before us. In fact, they are one and the same figure in every respect, with their ends reversed, and drawn through the water with the same motive power.

No. 1, velocity, 2·775 decimal feet per second; No. 2, velocity, 2·745 ditto; showing that, with the *full* part forward, No. 1 gains ·030 in velocity by these experiments. Mr. Russell selects No. 2 in preference to No. 1; and the load-water line of the *America* is also constructed the same in principle as No. 2; but then she is not propelled by the screw, but by sails, so arranged with a tendency to *raise* and not to bury the head of the vessel in the sea; and all the fast-sailing vessels of America are carefully masted, to give them buoyancy and a lively action, which it is impossible to give to vessels with the motive power acting at the extreme end, as in the instance of the screw. I am not aware if any other screw vessels are constructed upon the principle of No. 2, besides those of Mr. Russell, which it is very clear is the reverse of what they should be; and, if we take the fish as an example, where nature has placed the motive power in the tail, we shall see that the preponderance and quantity, in all instances, are placed before the middle of its length, and not behind it, as in No. 2; besides, the fish is supplied by nature with fins near the head, to counteract the depressive tendency of the tail. Taking nature a little further, as an example, we discover in all aquatic birds the propelling effects of the feet, which are placed nearer the tail than the head, depressing the breast and heaping up the water much the same as in the instance of the screw; and, if we wish to trace the depressing effects still further, we shall have it more fully developed in the frog, which, in descending to the bottom of the water, suspends the action of the fore legs; but these effects are now so clearly substantiated by the mechanical action of the screw, as to supersede the necessity of studying nature further, to teach us how to avoid, in future, its baneful consequences in a nautical point of view. I believe the *Great Britain* is not constructed on the "wave principle", or No. 2, and she has a bow above water, better calculated to keep her out of danger than the *Melbourne*, *Adelaide*, and *Victoria*, still she is obliged to be reduced from 1000 to 500 horse power; thus retiring from the contest which her constructors and engineer, Mr. Brunel, so confidently assured the public she would successfully maintain against vessels propelled by paddle-wheels.

There is an old saying, that "wit bought is better than wit taught;" and, although the purchase of this wit has been of a costly character, it is to be hoped that our maritime interest ultimately will not be the loser; but, as I have before remarked, why should England be constantly buying "wit" at such a ruinous waste of money which might be much better applied?

The failure of the screw, as a full-power steam vessel, it is to be hoped, will help to place the subject of steam navigation in a better position than it has yet been placed on the eastern shores of the Atlantic; or, in fact, in the western hemisphere, where it was first cradled and brought into useful activity for our example.

It is a fortunate thing for our enterprising teachers, that important subjects, such as the one before us, are not kept in abeyance by party-interested motives; nor do the American advocates of improvement depend on "distinguished patronage" to prompt them to move in a direction which the interest of all tells them should be left unshackled, and open to every one who may be capable of rendering the state some service.

England is now so surrounded by successful competitors in ocean traffic, that she cannot, as in times past, afford to trifle with and keep back marine improvements, as she once did, by the influence of those who made a monopoly of the sea; and the light forced into notice by late experience, may very possibly be of some service in checking the progress of marine schemes not calculated to make a more profitable return for the capital invested than ocean screw steaming.

Within a month, we have had further instances of paddle-wheel steamers crossing the Atlantic in a little over nine days from New-York to Liverpool; and from St. Thomas's to Southampton, nearly 4000 miles, in fourteen days; giving further proof that paddle-wheel steam-ships, with all the disadvantages of too deeply immersed wheels, can make the voyage to Australia, for certainty, in about half the time occupied by the *Great Britain*, and in less than half the time taken by the Australian line of screw packets.

We have had ample experience to show that the screw has not, *and cannot be made to realize the expectations of its adopters*; or why the retrograde movement which is now being made to bring it back to an auxiliary power? And I trust that I shall not be considered out of place in again repeating, if sailing ships average ocean voyages the same as the screw, at 30 per cent. less in costs, nothing can be more clear than that of its being a waste of public money, to force the screw into use where it will not pay. In addition to the late proofs in favor of the paddle-wheel, we have another striking instance in favor of sailing vessels—the American clipper-ship *Sovereign of the Seas*, just arrived at Liverpool from New-York, having run a distance of 1,608 miles in 135 hours; averaging 296 miles per day, or 12·73 knots per hour; her greatest speed being 427 miles in twenty-four hours. If steam cannot be made to propel ships at a higher rate than the average speed of ships propelled by the wind for ocean purposes, we had better abandon its use altogether; but, fortunately for the interest of man, daily experience proves that steam can, as a motive power, be made to propel ships at a higher rate of average speed, and it becomes our interest to avail ourselves of its use in a way most conducive to the general prosperity of the country; and so far as practical science has enabled us to apply it to marine purposes, we have discovered no mechanical process to which it can be so effectively applied as a motive power, as to that of the paddle-wheel, which, notwithstanding it remains in its original unimproved state, continues supreme as it respects average speed; and, if the great retrograde movement in bringing back the screw to auxiliary power, be impartially investigated, public opinion will be again directed to full-power steaming in the only class of vessels to which it can be safely and profitably applied.

Your obedient humble servant,

JOHN POAD DRAKE, *Naval Architect.*

London, July 12th, 1853.

[For Appleton's Mechanics' Magazine.

The Geology of the Present. The Mississippi Valley.

(*Continued from page* 201.)

The Greek term, Delta, originally meaning a triangular tract of land, is applied to the whole region ascertained to be composed of mud from the river.

The land in the vicinity of the mouth of the Mississippi is well known to be gradually encroaching on the Gulf, and has actually advanced in this direction several miles within the memory of persons now living. This advance is due to the deposit of solid matter brought down by the river; and the area thus formed is that intended in this connection by the Delta of the Mississippi.

It requires no very minute examination, or profound Geological knowledge, to prove that the Mississippi flows through banks formed by its own deposits, not only near its mouth, and as far back as the city of New Orleans, but actually, according to the report of Mr. Ellet, to a point above the mouth of the Ohio, and within two hundred miles of the city of St. Louis.

These wide fields of alluvial deposit are bounded on either side by an irregular line of bluffs, described in our quotation from Lyell, page 201, and vary in width from thirty to one hundred and fifty miles.

The first "rocks in situ," the first positive information of the original *terra firma* in the bed of the river, is at the village of Commerce, some hundred miles above the mouth of the Ohio, and 528 miles in a straight line from the gulf. At this place the channel is crossed by a rocky ledge, from two hundred to three hundred feet above the level of the sea, and over which, assuming the sea to have at one period extended its present level up this long frith of some five hundred and twenty-eight miles long and one hundred wide, there must have poured a cataract with which Niagara would hardly compete either in height or volume. But the fall may have been divided, or still less romantically consumed in rapids, far below; and all speculation is idle except with regard to that concerning the present condition and future prospects of this most valuable portion of our confederacy.

The Delta of the Mississippi, as now defined, is a broad strip of low alluvial ground, five hundred and twenty-eight miles long, from thirty to one hundred or one hundred and fifty miles wide, and forming an inclined plane, through which the Mississippi meanders and bends, making a course of about 1200 miles in its passage to the sea. The lower extremity of the plane is washed by the waves of the Gulf of Mexico; the upper, at the village of Commerce, is ascertained with tolerable certainty to be about three hundred and twenty feet higher, near the river. The whole delta is, for reasons which we shall soon see, higher by several feet at the banks than at the distance of a few miles from the river; this is true, independent of the artificial embankments or levees which have been erected. The natural condition of the river and delta, aside from the local changes continually progressing, washing away at one place to deposit at another, is dependent on an annual rise and fall of the water. The muddy stream, which in autumn flows sluggishly along, its surface being from twenty to forty feet below its banks, rises with the floods of winter and spring, and overflows in a thin sheet the whole area between the bluffs before alluded to. The water once out of its channel loses its velocity, and consequently its capacity to retain the matter held in suspension, which is deposited on the inundated territory, raising it each year by a certain very thin lamina, the material for which was washed from the hills hundreds of miles above. The immediate vicinity of the river receives the grosser particles, and is elevated more rapidly; the distant swamps farther back receive the clear water after this refining, and hold it till the river subsides and allows its gradual return, through natural bayous, or through branches at a lower point in the stream. This water of overflow possesses a gradual motion down the plane, but very trifling in comparison with that between the banks of the river; and in this view, the whole of the swamp lands of the delta serve the purpose of an immense reservoir to equalize the flow of this mighty stream. To how great an extent it thus serves will be attempted in figures further on.

This being the natural condition of this area, a little attention will show that the filling up of the whole valley of the Mississippi, with an industrious and enlightened people naturally tends to disturb it in two important particulars, both of which tend to produce the present alarming increase in the floods of the Mississippi the disastrous effects of which it is so important to provide against. First, the settlement of the whole country, which is steadily progressing, tends to facilitate its drainage and hurry down its floods; and second, the gradual extension of the levees is shutting out more and more of the water of overflow from the swamp lands, thus diminishing the area, and seriously impairing the effect of this great natural reservoir. At the late scientific convention at Cleveland a paper was read relating to this subject, in which it was assumed that cultivation of the land diminished the supply of river water. This is decidedly in opposition to the general opinion along the river; but however views may vary with regard to the absolute increase or decrease of the evaporation, none can doubt that the drainage is *hastened* in consequence of clearing and tilling the land. The wild prairies or the forest receive the rain and hold it long in their tangled grasses and underwood; and the small streams are choked with various obstructions, all of which it is the first object of the emigrant to remove. The tilled fields, on the contrary, pour their rain freely into the creeks and small rivers, which hurry on to swell the flood, against the spread of which the planters on the delta have raised a slender embankment. These settlers, originally finding the most valuable land in the country annually overflowed by a sheet of only about one foot in depth, have successively established plantations defended by levees, until they form almost one continuous line from the mouth of the Ohio to the sea. When this is completely accomplished, or rather, as this condition is still further approached, the river will assume an increased rise, which at and near its lower extremity, it is contended by Mr. Charles Ellet, in his able report to Congress,* must demand the most energetic measures.

Mr. Ellet has evidently stated the difficulties fairly, and endeavored to ascertain and present all the facts necessary to estimate its extent, and ascertain the best means, however expensive or laborious, by which to meet it.

Other causes, suggested by many are shown to be without appreciable existence, or to have so slight an effect as to be of no importance to this or the immediately succeeding generations. Among these are a supposed rise in the bed of the river, which supposition is thought to be groundless, and the diminution of the descent due to the lengthening of the plane. The very natural supposition, that the increased flow through the channel may scour out, and increase its sectional area, is thought to be, from careful observations and measurements taken within the last few years, progressing too slowly to be appreciable, such increase being only in consequence of, and perhaps centuries after, the increased discharge. A moderate velocity will suffice to keep open an old channel, in which, on the other hand, a considerable increase may flow for a long period without any very decided effect in accommodating the channel to the increased supply.

In support of this last position the Raccourci cut-off is a strong example. When the river, in its continual washing and depositing, jumps across a bend by breaking through a narrow neck of land, there is, of course, a strong current at that point, due to a considerable head of water. The Mississippi inclines on an average about three inches per mile. If a head of twelve inches is suddenly reduced to one, the inclination of the surface at that point will be very considerable, and the abrasive action on the sides and bottom very sensibly felt. The Raccourci cut-off was started by an artificial trench, and soon became the channel of the river; but its increase either in breadth or depth has of late been very slow, and at present, as will be seen below, its cross section, after three years' operation, is but little more than two-thirds that of the average of the channel. If this is the case in a cut-off, where every circumstance is favorable to a most rapid flow, the effect of a rise of surface of the whole river, in scouring out its channel, may be presumed to be slow indeed.

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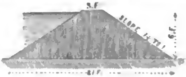
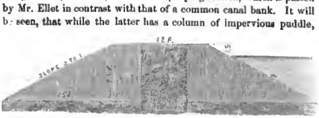
* Inundations of the Mississippi and Ohio Rivers. By Charles Ellet. Published by Messrs. Lippincott, Grambo & Co., Philadelphia, 1853.

The chief protection now afforded the extreme lower portion of the delta, according to Mr. Ellet, is the weakness of the levees above. Ruptures continually occur, and must continue from the nature of the case.

Every gallon of water excluded from the swamp raises the river, and assists it to break the feeble barriers; but with each rebuilding the levees are made stronger. It remains a subject for calculation, how high and how strong levees must be finally constructed to justify the establishment of a continuous line. The engineer familiar in any degree with the difficulty of constructing safe and durable embankments of the kind, will be surprised at the cheapness and evident inefficiency of the levees employed on the Mississippi. For a space of nearly seven hundred miles, both sides of this river are guarded by levees, constructed and maintained by the proprietors of the respective estates. The works being thus under the supervision of five thousand or ten thousand different individuals, perfect uniformity cannot be expected; the general construction being shown, however, in the accompanying section, which is placed by Mr. Ellet in contrast with that of a common canal bank. It will be seen, that while the latter has a column of impervious puddle, joining it to the more solid earth below, and has several times more breadth at the top, it has also a considerably greater elevation above the highest level of the water anticipated. The slender wall of mud on the Mississippi, if ten or twelve inches above the known high water marks, is considered tolerably secure.



Section of Levee.



Section of a Canal Bank.

[To be continued.]

Motive Power.

Among the English patents lately published appears the following, which we present as a curiosity or philosophical toy of some interest, but which can be, as appears to us at this moment, of no possible practical value.

To Edme Augustin Cameroy, of Paris, for improvements in motive-power engines, and in the application of motive power to the same. Patent dated January 8, 1858. (No. 12.)

This invention relates to a new system of obtaining motive power by the action of vapors, worked directly by means of a generator, condenser, and a separate, free, or detached piston. Steam, ether, chloroform, or any liquid easily vaporized, may be employed, the same liquid being constantly worked by being alternately expanded and condensed. Fig. 1 is a vertical section of this engine, taken through the longitudinal centre line of the cylinder and piston. A A is a long cylinder of small bore, fitted with suitable trunnions or journals, B B, on which it oscillates in stationary bearings on the top of standards C C, bolted to the floor, parallel to each other. This cylinder is accurately bored out, and is fitted with a loose piston D, capable of traversing freely from end to end of it. This piston (as shown in fig. 2) has two passages *e e*, running through it longitudinally, and provided with valves and springs *f*, to permit the actuating vapor to pass from one end of the cylinder to the other, when any excess of pressure arises at either end. The cylinder terminates at each end in wide flattened chambers G G¹, bolted by suitable flanges to the cylinder ends. These chambers serve as vapor-generators, and are made of corrugated metal, for the purpose of increasing their area of surface, and consequently their actuating power. They are bent to coincide with a curve struck from the centre of oscillation *b*, of the cylinder, and being intermediately connected by the segmental piece G², are made to form a semicircle, the chord of which is equal to the length of the oscillating cylinder A. H is a stationary reservoir or segmental heating-chamber, shaped to the line of curvature of the semicircle G G¹ G², and filled with hot water, fusible metal, or other fluid mass. This chamber is open at both ends, and, as the main cylinder A oscillates, the semicircle G G¹ G² traverses through it from end to end. J is a furnace for heating the reservoir H, by means of a flue passing beneath it. The antagonistic cooling system is kept up by a refrigerator K, at each side of the machine, consisting of a short horizontal drum having a corrugated surface for the enlargement of its effective area, and adjusted to revolve in a half-submerged position in a cold-water trough L, carried by standards M. Each drum is covered with felt or other absorbent material, so that its surface may be saturated with and take up a quantity of cold water as it revolves.

Fig. 2.

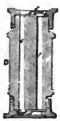
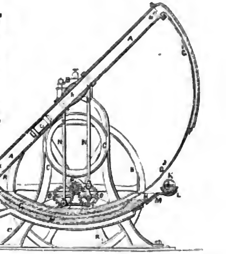


Fig. 1.



In commencing to work this machine, the attendant first adjusts it to the position shown in the drawing; the cylinder A being at or near an angle of 45° to the horizon. A small quantity of ether, chloroform, or other easily vaporized matter, is then poured into the other end of the cylinder through the aperture *u*; the fluid thus passed in flows down into the generator G. This being done, the port *u* is closed, and the furnace J lighted, in order to heat the chamber H. As the generator G is totally surrounded by the heating chamber, its contents speedily become vaporized, thus producing more or less pressure in the lower end of the cylinder and beneath the piston W. The effect of this pressure is, that the piston is forced up to the other and higher end of the cylinder, at the same time the air above it is forced out through the port *u*¹. The attendant next introduces through the port *u*¹, as much ether or chloroform as was previously supplied through the port *u*; this supply is allowed to flow into the generator G^2, the aperture u being closed as before.

When so prepared, the engine is left to continue working itself; the weight of the piston being carried up to the elevated end of the cylinder causes that end to descend, and brings the cylinder to the reverse angle, as indicated by the dotted lines. As soon as this reverse action of the cylinder commences, the convex surface of the generator G, on leaving its hot bath, traverses over its refrigerating roller K, thereby condensing the vapor and annihilating all pressure on that side of the piston. At the same time the opposite generator G^1, descends and passes into the heating chamber H: and the same action takes place at the reverse end of the cylinder; the pressure of vapor in the generator G^1 at once carries up the piston to the opposite end of the cylinder, and causes it to return to its original position. In this way, by the alternate heating and cooling of the vapors in the generators, a constant vibratory motion is kept up, which is imparted to the machinery to be actuated by means of a pair of connecting-rods N N, jointed at their upper ends to pins fastened in the oscillating cylinder, and set one on each side of the centre of motion of the latter; the lower ends of these rods are similarly connected to cranks O O, formed on shafts, each shaft carrying a spur-wheel which gears into a central pinion P, keyed on the end of the axle of the fly-wheel R. To stop the engine, it must be held so that the segmental piece G^2, shall be in contact with the heating medium, thereby preventing either of the regenerators from being heated, when vaporization of course ceases.

Various modifications of this engine may be employed to produce a similar result, and by fitting a number of cylinders on one shaft, the power may be indefinitely increased, and a continuous rotary motion of the main axis be produced.

Claims.— 1. The general arrangement of machinery, apparatus, or means for obtaining motive power, as described.

2.—The systems or modes of producing the alternate expansion and condensation of the actuating medium, as described.

3. The system or mode of obtaining motive power by employing steam or other vapor to elevate a weight or piston, the whole being contained in a single closed vessel, or in several vessels, in communication with each other.

4. The application and use of a motive-power machine, wherein the actuating force acts within a hollow cylinder, having no communication with the external atmosphere.

5. The application and use in such cylinders of a heavy piston or other weight, quite disconnected from the other details, the periodical displacement of such weight being the means of securing the motive power.

6. The application and use of vapor generators and condensers, as described.

7. The application and use of a heated bath for plunging the generator into, to produce the necessary vaporizing effect.

8. The system or mode of constructing refrigerators, as described.

LIST OF PATENTS

Issued from the U. S. Patent Office during the month of August, 1853.

Samuel Canby, of Ellicott's Mills, Md., for Grain Winnowers.

Claim.—The construction of the receiving and discharging passages for the grain; that is, the passage at the door, passage I and passage J, in the manner set forth.

Frank Dibben & Lewis Bollman, of New-York City, for Multiplying Gearing.

Claim.—We claim the employment in any manner as described, for the purpose of transmitting rotary motion, at a multiplied or decreased speed of two pairs of toothed or friction wheels being placed upon two axes, one of which is capable of revolving round the other, one wheel of each pair being on one axis, and the other wheel of each pair being placed upon another axis, as set forth.

Daniel Dodge, of New-York City, & Phineas Burgess, of East Boston, Mass., for Life Boats.

Claim.—We do not claim a boat having an opening extending completely through it, whereby it is rendered, by the addition of a floor, fit for service in opposite positions on the water.

But we claim the central fixed platform, which is secured in the opening of the boat in a plane passing centrally and horizontally, or nearly so, through the same, or which may be said to form a partition between two opposite recesses, as described, the said platform serving as a floor to the boat, whichever side is upwards, and being, from its fixed position, incapable of becoming disarranged by any accident.

G. W. Eitcheel, of New-York City, for setting up Ten Pins and Returning Balls.

Claim.—Setting up the pins of an alley by an apparatus operated from the head of the table or elsewhere, by means of a weight or weights attached to them by codds when combined with the elevation board, which raises and sustains the weight or weights to admit of the pins being knocked down, as described.

I also claim the use, at the back end of the table, of a delivery board applied and constructed as described, in combination with an elevator for the elevation and return of the balls, as described.

B. H. Green, of Princeton, N. J. for Carpenters' Clamps.

Claim.—The combination of the adjustable vibratory arms and reversible jaws, with the adjustable clamp, for the purpose of presenting jaws of different sizes and at different dimensions from each other, as set forth.

John Hartin of New-York City, for Mode of Drying Paper.

Claim.—Drying paper by passing it between opposite series of equal sized fans, which revolve with equal velocities; by which a pressure of air of equal force is made to act simultaneously on opposite sides of the paper, and thereby insure smooth and uniform surfaces upon the same, as set forth.

Samuel Hickok, of Buffalo, N. Y., for Railroad Car Seats.

Claim.—Constructing a railroad car seat by connecting and arranging the sliding seat with the revertible back, hinged at the extremity of the reversing arms, and combining therewith the double rachet bars in such a manner that it can be easily converted in either direction into a day or night seat, and, at the same time, not occupy more space than the ordinary stationary seat, as set forth.

I also claim the triangular foot rest, in combination with the sliding seat, whereby it is made adaptable to the seat, when used either as a day or night seat, as set forth.

L. S. Ingraham, of Cuyahoga Falls, Ohio, for Winnowers.

Claim.—The stair or fluted screen, constructed as set forth.

J. W. Jenkins, of Greenport N. Y., for Iron Posts for Fences.

Claim.—The arrow-headed or barbed bottom of the post, in combination with the twisted cross-piece, as set forth.

George Leonard, of Shrewsbury, Mass., for Fire Arms.

Claim.—A revolving fire guide, which, by the continued operation of the fire arm, shall successively communicate fire to the different charges of several barrels.

John Lewis, of Buffalo, N. Y., for Printing Presses.

Claim.—The swinging bail and the pressure bail, constructed as set forth.

E. L. Millis, of Rochester Depot, Ohio, for Corn Shellers.

Claim.—Reducing the larger ears of corn to be shelled to a nearly uniform size with the smaller ones, by passing the whole through between a toothed cylinder and concave, where the large ears are caught and partially reduced or operated upon preparatory to their passing with the smaller ones through between a second cylinder and concave, when the entire operation of shelling and separating takes place, as described.

Joel G. Northrop, of Syracuse, N. Y., for Printing Presses.

Claim.—The combination of the series of intermittingly rotating platens with a vibrating bed, when so arranged as that the delivery of the printed sheet is from the lower of the series of platens, so that it may drop from the platen on to the paper table, or into a drawer, as described.

Jones Patterson, of Franklinville, N. Y., for Friction Rollers.

Claim.—Fitting the bearing of a rolling car wheel on a fixed axle, with a series of friction rollers having bearing of large diameter to run in contact with the wheels, and of smaller diameter to run in contact with the axle, the latter being enlarged at the point of contact with the rollers, as specified.

A. B. Seymour, of Hudson, N. Y., for Rolling Railroad and other Iron.

Claim.—I do not wish to limit myself to the modes of application specified; nor do I claim the employment of a series of draw rollers to act in succession on the bar of iron or other metal to draw it into a required form.

But the employment of a series of pairs of rollers, so arranged that the pairs in the series shall be free to move from or towards each other to adapt themselves to the condition of the metal in the process of rolling, as specified.

Joshua Stevens, of Chicopee, Mass. (assignor to the Massachusetts Arms Company), for Repeating Fire Arms.

Claim.—Constructing and combining together, as described, the lock, trigger and mechanism for rotating and locking and unlocking the chambered cylinder, so that while, by a single pull of the trigger, the operations of unlocking and rotating the magazine or chambered cylinder, relocking it, and discharging the cock, shall be caused to take place by power applied to the trigger alone, the elevation of the cock, or the cocking of it, shall be previously affected by the hand of a person or means entirely separate from the trigger, as described.

I also claim the combination of the stirrup, the spring bolt and the lever, as specified.

I also claim the combination of the sectoral plate, made as described, with the spring bolt and slot, the said plate being applied and operated essentially as explained.

I also claim the method set forth, of constructing the lever, viz., of two parts (turning on one common pin), in combination with their confining and adjusting screws, as described.

G. W. Baynes, Thomas Hunty, and Minter Jackson, of Glenville, Va., for improvement in Bedstead Fastenings.

Claim.—The combination and arrangement of the tenons, A A, pins E E, tenons D and F, with a screw, for the purpose set forth.

William Beach, of Philadelphia, Pa., for improvement in Meat Tenderers.

Claim.—Forming a meat maul for the purpose designed, securing to one end of an oblong block of wood, whose opposite end is formed into a handle, a series of rows of tapered teeth of the form described, cast on a plate, or driven singly into the wood, as may be desired.

John Binder, of Chelsea, Mass., for improvement in Hinges for Folding Bedsteads.

Claim.—The method described, of constructing a hinge with the circular bearing surfaces, as set forth.

P. F. Charpie, of Mount Vernon, O., for improvement in Gun Locks.

Claim.—Connecting the dog to the hammer, by means of a screw passing through a curved slot in the plate, in combination with the packing which encompasses the curved slot, by which combination I am enabled to place the mainspring and dog on the inside of the lock-plate, and prevent the admission of moisture within the lock, as set forth.

Thomas Crossley, of Roxbury, Mass., for improvement in Printed Carpets.

Claim.—As a new article of manufacture, a single ply printed carpet, made by combining the warp and filling, in the manner described, and subsequently printing them on one or both sides; I having discovered that fabrics woven in this manner could be printed on one or both sides without the colors passing through and discoloring or intermingling with the colors on the opposite side of the fabric.

B. F. Delano, of Chelsea, Mass., for improvement in Rudder Brace.

Claim.—First, the brace connected with the rudder, as described and set forth.

Second, I claim the combination of the brace, with the elliptical tiller, or any other analogous device, for the purpose of actuating the rudder, by the application of power to the braces instead of to the rudder itself.

M. B. Dyott, of Philadelphia, Pa., for improvement in Facing Buildings.

Claim.—The method described, of supporting a veneering or facing of thin cast-iron, or other plates, upon their inside, and uniting the same firmly with the external surface of the building, by so fixing the plates in relation to the wall, as to leave a sufficient space between them, to allow a cement in a liquid form to be poured in to fill the space and all the interstices of the plate perfectly, solidify around and upon the hooks and other fastenings, and exclude the air and all dampness, whereby the veneering is strengthened, protected, and preserved, as set forth.

A. W. Graheart, of Beallsville, Ohio, for improvement in Machines for Preparing Spoke Timber.

Claim.—The arrangement of the adjustable bed, the bridle or clamp, the sliding-guide or gauge, and foot-lever, for the purpose set forth.

A. H. McKinley, of Higginsport, Ohio, for improvement in Socket for Auger Handles and Braces.

I do not claim the enabling the shipping or unshipping of a bit or auger from its stock or handle; but I claim the peculiar arrangement of mechanism by which I enable the shipping and unshipping of a bit and handle of an auger or other boring tool, that is to say, the socket having a circular head and vibrating cap, whose aperture can be made at one position to coincide with the mouth of the socket, and in the other position to oppose its straight edges to the projecting corners of the shank, the cap being retained in the desired position, by spring and notch, as described, or its equivalent.

Jacob Mumma, of Mount Joy, Pa., for improvement in Draught Apparatus of Seed-Planters.

Claim.—The combination of a tongue, having motion vertically and laterally, with the directing and supporting wheel, as set forth.

E. K. Root, of Hartford, Ct., for improvement in Drop-Hammers.

I do not wish to limit myself to the special construction specified, so long as the same effects are produced by equivalent means.

Claim.—The method of elevating the drops of hammers by means of a screw, having a continuous rotary motion in combination with the mechanism, or its equivalents, for disconnecting the drops or hammers from the screw, to permit them to drop, as described.

I also claim the method of disconnecting the drops or hammers by the rotation of the elevating screw, which is notched to catch and act upon the finger, or its equivalent, connected with the slide, to force it back and clear the thread of the screw, as specified.

I also claim, in combination with the slide which connects the drop or hammer with the elevating screw, and with the finger on the slide, or their equivalents, the employment of a catch-lever, or its equivalent, for holding up the drop or hammer, when it is liberated from the elevating screw, and there to hold it until it is required to be dropped, as described.

Lastly, I claim, in combination with the elevating screw, and with the catch that holds the side slide, when liberated from the elevating screw, or their equivalents, the employment of the rebound latch, which liberates the parts by the rebound, when the drop or hammer strikes, as specified.

Wm. Van Anden, of Poughkeepsie, N. York, for improvement in Trip-Hammer.

I do not claim elevating the hammer-shaft, by means of cams; neither do I claim the friction-rollers, irrespective of the particular manner of arranging or attaching them to the hammer-shaft, as shown.

Claim.—First, attaching a collar to one end of the hammer-shaft, said collar working loosely over a shaft which has a spring attached to it, for the purpose of forcing down the hammer-shaft; the shaft being provided with a set-screw, or its equivalent and lever, arranged as described, by which, upon properly adjusting said set-screw, or its equivalent, the hammer may be made to descend upon the block or anvil with greater or less force, as described.

Second, I claim the employment or use of the friction-rollers attached to a vibrating frame, arranged as shown, for the purpose of relieving, instantaneously, the cams from the pressure of the rollers, when the highest points of the cams have passed the lowest centres of the rollers, thus preventing the wearing of the cams at their highest points, as set forth.

By J. P. Schenkl (assignor to J. P. Schenkl & A. S. Saroni), of Boston, Mass., for improvement in Breech-Loading Firearms.

I do not claim uniting the breech to the barrel, by means of right and left screws, portions of which are cut away to enable the one to enter the other, the two being secured together by a partial revolution of one of them, as this has been done before.

Claim.—The combination of parts for the purpose of operating the movable breech, constructed and operating as described.

W. H. Babbitt, of Waynesburgh, Pa., for improvement in Hill-Side Ploughs.

Claim.—Constructing and arranging head in the hinge which connects the beam of the plough with the upright, so as to lock said hinge by means of a bolt before the pivot of said hinge, and by a lever behind said pivot, for the purpose of making the bearings in said hinge adjustable, as set forth.

A. G. Coes, of Worcester, Mass., for improvement in Screw-Wrench.

I am aware that the movable jaw has been moved by means of a screw; I do not claim such to be my invention; but I claim the combination and arrangement of the screw tube, its external and internal screws, the screw on the shank, the annulus and its left screw, as applied to the sliding-jaw, the whole being made to operate together, as set forth, enabling a person to readily move the sliding-jaw on the shank, with a velocity compounded of the velocities of motion of two left screws on two right screws, as described.

W. & S. G. Coleman, of Providence, R. I., for improvement in Ship-Block.

Claim.—The described mode of constructing the hook and eye staple of the ship's block, and supporting it within, and by means of the cheeks without, any extension of it around and in contact with the sheave-pin, and whether each of the cheeks is made whole or in two parts, as specified, and in combination therewith, we claim the mode of sustaining the sheave-pin, and connecting the two parts of each cheek, viz., by a metallic rod extended through them, and directly under and against the sheave-pin.

A. C. Gallahue, of Alleghany city, Pa. Antedated Feb. 18, 1853, for improvement in Machinery for Pegging Boots and Shoes.

Claim.—First, the sliding-lever, having a hook thereon, which, passing through slots in the uprights of the turn-table, secures the last to said table, by the introduction of the wedge, as set forth.

Second, I claim the turn-table mounted on the sliding-table, which works on ways on the moving-table, and is actuated by springs, for the purpose of keeping the edge of the sole at all times in contact with the gauge, when this is combined with mechanism for giving the turn-table a semi-revolution at the point where its centre is brought opposite the awl, by the motion of the table, that regularity in inserting the pegs may be secured.

Third, I claim the combination of the spring, lever, catch, or their equivalent, sliding-wheels, racks, miter-wheels, by which a semi-revolution is given the turn-table (while the pegs are being inserted around the heel), by the shifting of the cog-wheel from rack 7 into 6, on the release of the lever from the catch, and the return of the cog-wheel into rack, on the release of the spring from the catch, by which means it acts on the upper side-lever, as set forth.

Fourth, I claim the cam and rod, secured to the hammer and helical-spring, by which a graduated driving-stroke is given the awl and its rod, in combination with cam 2 rod 11 (upon which slide the hammer), and helical spring, by which a driving-stroke is given the peg-driver alternately with that of the awl and its rod; it being understood that I do not claim the general feature of a hammer and rod carrying an awl, and spring for driving the awl, operated by a cam, as this has been done heretofore, but the particular mode or combination in which they are used, as claimed.

Fifth, I claim giving the peg-tube and driver a side motion, independent of the awl and awl-rod, by means of the cam and lever, or their equivalent, for the purpose of bringing the peg directly over the hole punched in the sole of the shoe by the withdrawn-awl, as set forth.

Sixth, I claim the combination of the cam and stirrup, with the swung peg-cutter, by which the peg-wood is split with the grain of the wood from below, by the knife, and at the same time forced in the tube, it being understood that I do not claim the general feature of a peg-cutter forming one side of the tube through which the peg is drawn, but only the particular mode of applying it, as claimed.

Gibson North, of Philadelphia, Pa., for improvement in Oven Doors of Cooking-Stoves and Ranges.

Claim.—The application of an adhesive coat of enamel, or other substance answering the same purpose, to the inside of the oven doors of ranges or cooking-stoves, as described.

A. R. Tewksbury, of Boston, Mass., for improvement in Boat or Scow.

Claim.—The method of constructing a boat, viz., by attaching its sides and ends to its bottom by water-tight hinges, in combination with connecting the edges of the sides and ends by water-tight flexible gores, as described, so that the boat may be unfolded, or the sides and ends be turned down into the plane of the bottom thereof, as explained.

Henry Stanton, U. S. A., for improvement in discharging Breech-Loading Firearms.

Claim.—The method described, of firing the charge of breech-loading arms, by the breech itself, in the act of closing, thereby dispensing with the ordinary lock, and greatly simplifying the construction of arms, and diminishing correspondingly their cost and liability to get out of order, and increasing their durability and efficiency.

I also claim the method of igniting the charge by shearing through the fulminating compound attached to the cartridge, as set forth.

Luther Atwood, of Boston, Mass., for Processes for Purifying Alcohol.

Claim.—The use of the manganates and permanganates existing as soluble compounds, however obtained, for purifying alcohol so as to adapt to nice purposes.

J. P. Moinier & P. H. Boutigny, of Paris, France. Patented in France, Jan. 18, 1853, for Generating Steam.

Claim.—In generators for generating steam at high temperature from water introduced into the generator when in a highly heated state, injecting or introducing water from the top or near the top of the generator, when this mode of feeding or introducing the water is combined with the series of perforated metallic diaphragms described, arranged one above another in the generator, so as to subdivide the water, and at the same time increase the evaporating surface of the generator, as described, the water being gradually heated, and subdivided in its passage through the apertures or meshes of the diaphragms before it comes in contact with the more highly heated surfaces of the generator, as described.

J. B. Duff, of New-York City, for Soap-Cutting Machine.

Claim.—Making the wire knives, arranged and set with weights capable of yielding, so that they will form a loop in passing through the soap, and consequently cut it smooth and straight in combination with the feeding slatted bed, or any other equivalent device for feeding and forcing the soap up to the said yielding wire knives, the whole being as described.

M. J. Gardner, of York, Pa., for Oscillating Steam Engines.

Claim.—The mode of introducing the steam, the circular steam tubes, the circular steam chest, and packing boxes, as described.

I do not, however, confine myself to the precise position or dimensions of the various parts described, but to use such positions and dimensions substantially the same, as may be best adapted to produce the desired effect.

Peter Horn, of Hagerstown, Md., for Seed Planters.

Claim.—The spring, in combination with the projection and arm or lever, for the purpose of opening and closing the recess through which the seed passes, as set forth.

Second, I claim the arm or lever, in combination with the lever and fulcrum, for the purpose of raising or lowering the drill tubes, and operating the springs, as described.

F. B. Parker, of Queensville, Ind., for Hay Rakes.

Claim.—The spring catches, projecting downward from the front ends of the hand bars, and provided with sloping lips, which, bearing upon the front tines, assist in holding the rake to its place until relieved by the withdrawal of the main stop, as described.

Milton Roberts, of South Levant, Me., for Arrangement of Cutters for Turning.

Claim.—Arranging straight-edged and grooved cutters on a frame moving parallel to the axis of the lathe, when said cutters are placed in pairs obliquely to the piece to be turned, each set forming salient angles with each other in the frame, by which arrangement each acts by a gradual drawing cut upon the piece, the grooved tools following to finish the work.

Samuel Vansyckel, of Little York, N. J., for Grate Bars.

Claim.—Forming a hook or catch upon the under side of the grate bars, and passing through or over said hooks, or catches, a holding bar to prevent twisting or warping, as described.

Lettie A. Smith, of Pineville, Pa., for Butter Workers.

Claim.—First, the combination of the cooling drawer, or ice box, with a butter tray, as described.

Second, I do not claim in general the device of the working lever in combination with the butter tray or table, but I claim forming such working lever with acute angles at the sides of its working face, so that it may serve the double purpose of breaking or pressing the butter and turning it over.

Wm. M. Warren, of Watertown, Ct., for Railroad Car Seats.

Claim.—The manner in which the foot-boards are constructed and arranged, viz., the foot-boards being attached by joints to slides, said slides having racks on their upper surfaces, and working on beds connected by hinges, the under sides of the slides being provided with spurs or clicks, which catch into the racks, and retain the foot-board, when pressed upon by the foot; the beds being retained underneath the seat, when the foot-boards are not in use, by means of the catches, or by any other convenient mode.

L. A. B. Walbach (deceased), late of the U. S. A., for Boring Cannon.

Claim.—The method described of boring cannon or the barrels of other ordnance or fire-arms, by perforating the same with an annular hole, which leaves a central core, in combination with a second operation for detaching and removing the core, as specified, whereby the amount of material to be reduced to chips, the time and labor of boring, and the wear of tools, are greatly diminished, and the accuracy of the work increased.

I also claim the transverse cutter, or the equivalent thereto, for grooving or cutting off the base of the core, as specified.

I also claim the method described of ascertaining the quality of the gun, by taking out a core of sufficient diameter and length from the axis or centre of the bore to be tested mechanically or otherwise.

Zachariah Allen, of Providence, R. I., for Counterpanes.

Claim.—The ribbed counterpane described as a new manufacture, it being so made that the thickness and twist of the chords forming the ribs on the same, by their tendency to untwist, will give to the said ribs a wavy or undulating surface, as set forth.

Henry Ritchie (assignor to S. C. Thompson, G. W. Westerfield, & Henry Ritchie), of Newark, N. J., for Padlocks.

Claim.—The combination of the bolt guard, and the double-toothed tumbler, one tooth of said tumbler fitting in the shackle, and the other tooth fitting in the notch at the back of the bolt, the bolt, guard, and tumbler operating as set forth.

Snow Magoun, of Newton, Mass. (assignor to E. N. Moore & C. H. Crosby, of Boston, Mass.), for Cutting and Bevelling Printers' Rules.

Claim.—The machine described for cutting and bevelling printers' rules, constructed with a sliding tool carriage, which carries the cutting tool forward and back across the rules, as set forth.

Jonathan Foreman, of Boston, Mass. (administrator of E. W. Foreman, deceased, late of New Rochelle, N. Y., and assignor to Henry W. Sears, of New York City), for Diving Bells.

Claim.—What I claim as the invention of the said Foreman is the combination of the reservoir of compressed air at the surface in connection with the diving chamber or bell, and the arrangement of the movable block or pulley, as described, whereby the chamber or bell may be moved and directed at the will of the operator within, as set forth.

E. S. Snyder, of Charlestown, Va. Additional improvement; original patent dated June 18, 1848, for Machines for Separating Straw from Grain.

Claim.—Having set forth, in addition to the original specification, the utility of my additional improvements, I claim the peculiar construction of the rotary apparatus, formed of concavo-convex aprons or shields, combined with the curved prongs, the said rotary apparatus used in combination with the threshing cylinder, as set forth.

I also claim setting the spout at about an angle of 45 degrees with the horizon, and adding the escape piece, to prevent the grain from flying about.

O. S. Leavitt, of Maysville, Ky., for Hemp and Flax Breaking Machine.

Claim.—I do not limit myself to the precise construction and arrangement of parts specified, as I have only described the mode of application which I have essayed with success.

I claim the combining apparatus, as described, in connection with the pieces which move alternately up and down to hold the hemp or flax against the action of the combs.

Wm. A. Mitchel, of Brooklyn, N. Y., for Machine for Distributing and Composing Type.

Claim.—I do not claim arranging the composing apparatus so that each type has to travel nearly the same distance to the point of delivery from the point at which it is dropped, as this has been effected by grooves, but I am not aware of any apparatus in which a combination of belts has been arranged with a view to all the types taking an equal time to travel from the point of deposition to the point of delivery, thereby carrying the types with certainty, and avoiding all liability to stick or get into disorder.

I do not limit myself to the precise arrangement of the belts as long as the same end is attained, neither do I limit myself to the number or size of the parts, as these must be varied to suit the types, and the capacity required. But I claim, first, the feeding belt or belts combined with the inclined plane, wheels and grooves to distribute the type, in the manner specified.

Second, I claim the mode shown for forming the distributing stick, with the points, spring, lips and keys, so as to drop one type at a time on its side, as specified.

Third, I claim the bridge and form of groove to separate the thick from the thin types as they slide down the incline, as specified.

Fourth, I claim a series of belts of length increasing towards the point of delivery of the types, in combination with a diagonal belt to receive and convey the said types from the series of belts to the composing table, or other point, in the order in which the types are dropped on the series of belts, as specified.

Fifth, I claim fitting the key for dropping the types so that it shall give a partial rotary motion to the shaft, to operate on the fork or any analogous device to drop the types.

Sixth, I claim the fork and blocking piece or stopper, to drop one type at a time, when moved by the key, or any similar means, as specified.

Seventh, I claim the composing wheel to receive and set up the types, either in the composing or distributing apparatus, as specified; and I claim the combination of the said wheel with the fingers on the wheel or with the bar, to supply said wheels, as specified.

Frederick Nishwitz, of Williamsburgh, N. Y., in Grain Harvesters.

Claim.—First, the combination of the fingers and cutters, or their equivalents, constructed, arranged and operating as described.

Second, I claim the employment or use of the flanged pulleys, arranged as shown, for the purpose of throwing or detaching the grass or grain from the belts.

Samuel Darling, of Bangor, Me., for Grinding and Shaping Metals.

Claim.—The combination of the holder of the article to be ground with a grindstone or grinding disc, as set forth, so that the article and the stone will change positions relatively to each other during the operation in three directions, namely, towards each other and parallel with and transverse to the axis of the stone.

Andrew Ralston, of West Middletown, Pa., for Saw Mills.

Claim.—First, sawing logs, or other descriptions of timber into lumber, by means of a reciprocating saw operated in a horizontal position, as set forth.

Secondly, I claim such an arrangement and combination of the horizontal saw with the other parts of the saw-mill, that the saw will run through and beyond each end of the log, or other description of material operated upon, and whilst in that position will be automatically let down a distance equal to the thickness of stuff desired to be cut, and the motion of the carriage reversed to bring the saw again into action without stopping the machine, and so on until the log or other material operated upon shall be entirely sawn into the dimensions required, as set forth.

Thirdly, I claim connecting the operating pitman with the saw gate, through the medium of a secondary pitman, connected with the saw frame and saw gate, substantially as described, so that the operating force shall be applied in a direction nearly coincident with that of the saw in its successive positions, for the purpose set forth.

Stephen P. Ruggles, of Boston, Mass., for Machine for Cutting Sheet Metal.

Claim.—So hanging a traversing and a fixed cutting blade, one or both, as that their cutting edges shall not overlap or come in contact with each other, by which means I am enabled to divide sheets of metal without twisting or warping their edges, and at great saving of power, substantially as described.

I also claim connecting the upper and lower portions of the frame when each carries one of the cutters on eccentric bolts, suitably provided with screw and nut, or their equivalent, for giving the blades on the said two parts of the frame a perfect adjustment one above the other, as described.

Daniel Winslow, of Westbrook, and Perley D. Cummings, of Portland, Me., for Paper Files.

Claim.—We do not claim a file or bill-holder, as made of two plates of wood, or pasteboard, or metal held together and upon the file of paper, by one or more elastic bands; but we claim the combination of the plates with the elastic bands, so arranged as that the side edges of the top plate shall be bent down upon the bands and hold them securely, while the side edges of the bottom plate are turned, but left far enough from the bottom plate for the bands to move freely between them and the said plate, the edge lips of both plates being so bent inwards and rounded on the corners as to protect the bands from being chafed or worn, as described.

Charles Weston, of Salem, Mass., for Machines for Splitting Leather.

Claim.—The arrangement as described, for exerting a constant and uniform pressure upon the leather, and at the same time allowing the spring plate to yield to the inequalities of the hide, the same consisting in a spring rack for holding the arm which is connected to the spring plate, by the turning shaft and cams, as set forth.

William Wigston, of New-York City, for Apparatus for Purifying Gas.

Claim.—Constructing the scrubber or float with a cavity, to receive the gas above the surface of the fluid and partly submerged passages leading from the said cavity through the sides of the float to allow the escape of the gas from the cavity, and cause its distribution over the surface of the fluid in thin streams, to produce a diffused contact with the fluid, as described.

Elliot Savage (assignor to Franklin Roys & Edward Wilcox), of Berlin, Ct., for Machinery for Cutting and Bending Metallic Discs.

Claim.—The combination and arrangement of the roller M with the roller B, and the bending roller, so as to operate together, and independently of the clamps, as specified.

Elijah Valentine, of Palmer, Mass. (assignor to Abel Bradway, of Monson, Mass.), for Shingle Machines.

Claim.—The series of rollers, &c., placed above the platform, when they are combined with the ledges, which rise from the sides of that portion of the platform that receives the rived shingles to be operated upon, and so arranged that when the rived shingle is first carried forward, the said rollers will be elevated above its upper surface by the said ledges; and when the driver is drawn back, it will at the same time pass from under the said shingle, and from under the rollers, thereby allowing the shingle to fall upon the platform, and the rollers to fall in succession upon the upper surface of the shingle, for the purpose of giving to the said shingle such a shape and position upon the platform that it will be carried outwards again by the next forward movement of the driver, and be operated upon by the dressing knives, as set forth.

James T. Asbury, of Taylorsville, N. C., for Straw Cutters.

Claim.—The combination of the three cutting knives, as described, with the recessed arms, whereby one-third of the feed of straw is cut successively by each knife, the protruding uncut portion passing through the recesses in the arms during the operation, as specified.

Philos Blake, Eli W. Blake, & John A. Blake, of New Haven, Ct. Antedated March 6, 1853, for Nut-Crackers.

Claim.—We do not claim the use of jaws, forced together by a lever, to crack nuts, since that device is found in the common nut-cracker; nor do we claim the mere divergence of the jaws, irrespective of their position in relation to the axis of motion, since the jaws of the common nut-cracker diverge when opened to receive a nut; and it also diverges in a plane which is at right angles to the axis of motion, and consequently nuts of different sizes are received between them at different distances from the axis; whereas, the jaws of our instrument diverge in a plane which is parallel to the axis of motion, and consequently nuts of different sizes are received between them at the same uniform distance from the axis of motion, which condition, or a near approximation thereto, is indispensable to the cracking of nuts of different sizes, between jaws whose motions are limited by stops in both directions, as described.

We claim, therefore, first, the divergence of the jaws in a plane which is parallel to the axis of motion, as described, whereby nuts of different sizes are all received at a uniform distance from the centre of motion.

Second, we claim the divergence of the jaws in a plane parallel to the axis of motion, in combination with the two stops, collectively, which limit the motions of the movable jaw, as described.

Third, we claim the divergence of the jaws in a plane parallel to the axis of motion, in combination with their extension beyond the supports of the axis, whereby the line of the axis of motion is brought in close proximity to the acting faces of the jaws, without impairing free access to them to introduce and remove the nuts.

In the foregoing claims we do not intend to confine ourselves to a strict parallelism between the plane of the jaws and the axis of motion, since it is obvious that some variation therefrom would not defeat the object aimed at, by approximating to parallelism in distinction from placing the plane of the jaws at right angles to the axis of motion, as in the common nut-cracker. Indeed we have contemplated as a possible improvement the placing the outer ends of the jaws a little further from the axis of motion than the other end, with a view to have them act on large nuts, through a space somewhat greater than in smaller ones.

James Barnes, of Franklin, N. Y., for Machine for Edging Leather Straps.

Claim.—The combination of the parallelogram and inverted dividers, as a regulating gauge to work in front of the edge of a curved knife, so that strips of leather of different widths may be rounded to feather edges, with the same perfection without the change of knife or any part of the machine, the whole being as described.

Victor Beaumont, of New-York City, for Printing Presses.

Claim.—I do not claim a type cylinder, or any particular mode of holding the type in place, or the using any portion of the periphery of the type cylinder for a distributing surface.

But I claim, first, the combination of two or more impression cylinders with a type cylinder, so arranged as to print all over on one side a continuous sheet of paper, as described.

Second, the combination of the eccentric and rod, and the folder, so arranged as to lay the continuous sheet in piles, after being printed on one side, as described.

Third, the combination of the indented knife with the roller, and so arranged as to cut the sheet into proper length, as printed.

Wm. Compton, of New-York City, for Pianofortes.

Claim.—The means shown and described for securing the strings into the angles of the T's by the combined operation of the up-bearing bridge or rest, to which the T's are connected, and crossing and drawing the strings together at said bridge or rest, for the purpose of relieving the sounding board or rest plank of vertical pressure, as specified.

Henry Hunt, of Brooklyn, N. Y., for Sealing Preserve Canisters.

Claim.—Excluding air from the articles put up in closed canisters, or other vessels, by providing the canister or other vessel with a metallic tube or its equivalent, attached thereto, and after the air has been exhausted through said tube, pressing it together air-tight, that it may be soldered or cemented, to render the joint permanently air-tight, as described.

Jos. K. Lindner, of New-York City, for Horse Collars.

Claim.—The union of the hame plate and collar, in combination with the lock plate, as set forth.

I also claim the triple fastening of the lock plates, in combination with the outward and backward spring of the hame plate, as set forth.

John Moyle, of Martinsburgh, Va., for Straw Cutters.

Claim.—The combination of the rake and holder, constructed as described, for feeding the straw to be cut, and binding it to the box as specified.

Charles Montague, of Pittsfield, Mass., for Printing Presses.

Claim.—Such a combination and arrangement of the cylinder and bed, that whilst one sheet is receiving its impression the sheet to receive the next impression will be carried forwards upon the cylinder, nearly to the bed, for the purpose of being in readiness to commence receiving its impression the moment after the bed starts upon its next forward movement, as set forth.

Charles Montague, of Pittsfield, Mass., for Printing Presses.

Claim.—Having described my press for printing on a continuous sheet, I claim the combination of the intermittently winding cylinder and feed roller, or their equivalents, with the reciprocating pressure cylinder and bed, and rollers, arranged and operating in such a manner as to successively make an impression on the continuous sheet, at each movement of the bed, as set forth.

In combination with a double set of inking rollers, I also claim the arrangement of the arms for inking both sets of rollers from a fountain placed vertically below the impression cylinder, substantially as described.

Stephen Meredith, of Erie, Pa., for improvement in Feed Apparatus to Gas Generators.

Claim.—The peculiar construction of the retort, as described, viz., having the retort of the cylindrical shape, or of other suitable shape, and placing within it a revolving cylinder, which, as it rotates, constantly presents a heated surface to the fluid, and converts it into gas, preventing the fluid from cooling the retort, and also preventing the formation of any incrustation on the same, as set forth.

James Spratt, of Cincinnati, Ohio, for improvement in Bottle Fastenings.

Claim.—The application of the cup or cavity, and aperture, for sealing preserved edible substances, as set forth.

W. W. Spafford, of Boston, Mass., for Machinery for Planing Metals.

Claim.—The combination of the receiving table or plate and its arm (composing the radial arm), the adjustable centre-pins, or their equivalents, and the brace, together with the main planing table, and its supporting frame, the same being made to operate as specified, and for the purpose of adapting the planing machine to planing in curved lines, as set forth.

Gideon B. Smith, of Baltimore, Md., for Counterfeit Coin Detecter.

Claim.—A gauge or hole just large enough to permit the genuine coin to pass through, arranged in combination with a lever, acting below said gauge, balanced so that the weight of such coin will depress it so as to let said coin slip down through said gauge, which is too small to allow any spurious coin to pass which is larger than the genuine, the lever being so balanced, that any coin lighter than the genuine will not be heavy enough to depress it; so that all spurious coin, whether too large or too light, will stop in the gauge, while the genuine will slip through and fall out below, as described.

Henry L. Weeks, of Hannahatchie, Geo., for Cotton Gins.

Claim.—First, arranging and securing the boxes in which the ginning rollers operate in a revolving or adjustable frame or box, or its equivalent, so that the rollers can be adjusted, or set at such an angle as may be requisite or desirable, as the condition of the cotton or other circumstances may require, so as to discharge the seed, or facilitate the falling from the rollers after the cotton is drawn off by the rollers.

Second, giving to the feeding aprons, or equivalent feeding devices, different velocities, for the purpose of spreading, distributing, or drawing apart the balls of cotton, so that sand and dirt may fall out, and not be carried to the ginning rollers.

Thirdly, passing the cotton after it is ginned between double aprons, or equivalent devices, when said aprons or devices move with less velocity than the ginning rollers, for the purpose of compressing and making more compact the cotton after it is ginned.

Thomas Warner, of Chicopee, Mass., for making Twisted Gun Barrels.

Claim.—First, a new manufacture of gun barrels, made out of solid bar, with the fibres of the metal having a gradually increased twist from the inside to the outside, as specified.

And in the process I claim making twisted barrels by twisting a bar of metal of the required size, when in a heated state, and then boring out the calibre, for the purpose specified.

Benjamin Irving, of Green Point, N. Y., for Paddle Wheel.

Claim.—Arranging and combining the floats so as to form a series of buckets of rhombic or substantially similar form, as set forth.

Thomas Allison, of Milton, N. Y., for Straw Cutters.

Claim.—I do not claim cutting straw in all oblique directions by means of spiral knives set obliquely around the periphery of a cylinder which has its axis set parallel with the axis of the feed trough, and which operate in combination with a parallel feed roller.

But I claim the construction and arrangement of the adjustable feed roller, which is made gradually tapering from its ends to its centre or middle, in the line of a curve, and arranged at an angle to the axis of the feed trough, and made to operate in combination with the cylinder of straight knives, and thereby facilitate the operation of the machine, as set forth—this arrangement rendering the machine less expensive, and more easy to be managed and kept in order.

L. H. Davis, of Kennet Square, Pa., for Corn Shellers.

Claim.—The introduction of the wheels and arms attached to the springs, and regulated by the screws, as described, for the purpose of stripping the gear of the kernels, as specified.

I also claim the flanges upon the gear covering for protecting the gearing from the admission of shelled corn, as set forth.

Porter Dickinson, of Amherst, Mass., for Corn Shellers.

Claim.—The combination of the revolving spring-shellers with the tooth rollers, operating as described.

Stephen Morse, of Springfield, Mass., for Iron Car Brakes.

Claim.—The spine having the point of suspension and socket, with the open spaces and brace plates, in combination with the rubber or friction surface plate, as set forth.

Hiram Sands, of Cambridge, Mass., and Gary Cummings, of West Dery, Vt., for Brick Machines.

Claim.—We do not claim the mode of operating the mould carriage by means of a crank acting upon bars running across or attached to the mould carriage, as that has been employed before in the brick machine of James Dane, patented October 24, 1848; nor do we claim the mode of operating the pressing piston, by means of a lever actuated by revolving cams and connecting rod; nor do we claim the arrangement thereof with the cam shaft made to pass beneath the pug mill, and thus operate the mould carriage by means of a reversing gear applied to said shaft, as the like arrangement is contained in the patent of Dane, Healy & Cummings, Aug. 5, 1851; ante-dated June 17, 1851.

But we claim the modification of such arrangement, by substituting for the shaft with reversing gear the shaft with continuous motion, operating the carriage, and producing the intervals of rest, by means of the crank pin acting alternately upon the studs connected with the mould carriage, whereby we obtain greater certainty and precision of acting the machine, with greater simplicity and durability.

Also, in combination with the piston and the lever, we claim the slot in the lever, the slotted bearings and the movable fulcrum pin, the connecting fork and hand lever, the same being for the purpose of increasing or diminishing the amount of pressure of the piston on the clay in the mould, as specified.

Samuel H. Turner, of Brooklyn, N. Y., for Printers' Ink.

Claim.—The employment of colophonic tar, produced and combined as stated, both in the manufacture of printing ink, and also as a varnish used by printers, to modify the condition of their ink to suit the temperature of the weather, and the kind of work to be executed, as specified.

From Newton's Repertory of Arts.

Proceedings of the Institution of Mechanical Engineers, Birmingham, England.

The paper read was "*On Railway Axle Lubrication*," by Mr. W. Bridges Adams, of London.

In the economy of railway transit an idea has prevailed that increase of speed increases cost in a compound proportion, in many other things than the mere excess of fuel consumed in the locomotive. This is correct only in reference to imperfect appliances. If, for example, the rails deflect beneath the rolling loads, the substructure will be displaced, and increased speed will greatly increase the displacement. If the wheel peripheries be out of order, the greater the speed the greater will be the destruction; and so also if the rail surfaces or joints be out of order. And in proportion as the springs are inefficient, *i. e.*, are non-elastic, or do not act through sufficient space to moderate the shocks, so will the destructive wear be increased by increased speed. But were all parts of the system—ballast, sleepers, rails, wheels, axles, journals, bearings, lubrication, and springs—rendered as perfect as is within the scope of mechanical art, there seems to be no reason why increased speed should involve any extra cost beyond the increased consumption of fuel, oil, and grease, provided all parts of the system be proportioned to each other.

In increasing speed with imperfect mechanical arrangements, one of the most prominent difficulties occurs in preventing axles and axle-boxes from heating; the cause of the heating is in the imperfect lubrication. The word lubrication literally signifies slipperiness, but this does not express the precise action. Oil or grease, or soap interposed between two metallic bodies moving one upon the other, is composed of a series of small globules, which keep the bodies separated, and serve as rollers. The surfaces of metallic bodies, however apparently smooth, are composed of salient and re-entrant angles of larger or smaller sizes, according as the metal is hard and polished, or soft and rough. Therefore the more imperfect the structure of an axle and bearing, the more viscid must be the lubricating material to keep them from contact. If the cushion of lubricating material be insufficient in extent, contact ensues between the salient angles of the metal, and heating takes place to such an extent as to boil away the lubricating material and drive it off.

In calculating the surface bearing of axles, there are two circumstances to consider:—First, the actual weight to be borne; and, secondly, the amount of concussion adding to the effect of the weight, which latter will much depend on the efficiency of the springs to moderate the effect of the shock.

Before the advent of railways, mail coaches and private carriages, with a maximum weight of 3 tons, were constructed with axles, case-hardened, and with a bearing surface on each arm equivalent to 30 square inches. This is equivalent to about 56 lbs. per square inch on the bearing.

Mr. Nicholas Wood, in his experiments on axle friction, found that with the best oil, and with favorable circumstances, a superincumbent weight of 90 lbs. per square inch gave the minimum of friction.

Some of the earliest railway axle-bearings were 4 in. in length by 2¼ in. diameter; something under 14 inches of total bearing surface, fitted, according to Mr. Wood's calculations, only for a wagon of 2 tons total weight. It would seem as though these sizes had been calculated from the fixed shafting of factories, without any calculation of concussion. Probably this was the reason why viscid soap was substituted for fluid oil; increasing the toughness of the material used for lubrication to make up for the want of bearing surface. In railway practice, it is found that the soap or grease which serves well in the winter, is too fluid in the summer; a sure proof that the bearing surface is far too small for any lubrication with oil, which offers the minimum amount of friction. A strong objection to soap lubrication is, that it requires a considerable amount of friction in the winter time to make it fluid; and it is sometimes difficult to start a train into motion when the grease has been frozen.

In the wheels of highway carriages, the oil chambers are contained within the wheels, and revolve with them; which process involves the efficient lubrication of the axle. In the axle-boxes of railway carriages the grease or oil does not revolve. In the highway wheels the oil always has a tendency to rest in the well or magazine below the level of the axle. In the ordinary axle-boxes of railway carriages the grease or oil is above the level of the axle; and as the axle revolves, the oil or grease, or rather the grease (oil not being used, except in engines) passes through a hole or holes in the bearing brass, which lies on the upper half of the axle; and thus the process is like that of a hand-mill; the lubricating material is supplied on the upper surface of the axle, and passes away at the lower like grist. To make the lubrication more certain, the holes are of large size; and this involves an evil by diminishing the bearing surface at the most important point. If these holes get stopped, the lubrication ceases, and heating ensues; and there are no means to remedy the evil, save by lifting the bearing from the axle and inserting more grease.

Thus, in the ordinary railway grease-box, there is not only a great waste of grease, but also a very imperfect mode of securing lubrication. The well-made case-hardened axles of a common road carriage are capable of running 5000 miles over a bad road, with once oiling, with a small quantity of oil; while railway axles require greasing every 100 miles or less, with some few exceptions.

Impressed with these imperfections, the writer, some years back, began to consider the best means of remedying them. It was evident that the only mode of applying grease or oil to a large surface of the axle-bearing, was at the under side. In the common mode of an open bottom this was scarcely practicable; and the question was, could the bottom be effectually closed without so confining the axle as to make partial heating dangerous. This was accomplished by applying a flexible connection between the axle and the inner side of the axle-box, and making the bottom of the box tight. In this mode, the grease filling the lower part of the box, the whole under surface of the axle was bathed in it, while all dirt and grit were excluded. Moreover, the grease being as it were in a well below the axle, any accidental extraneous matters could sink to the bottom, and not be brought in contact with the wearing surface. And supposing the upper holes to be entirely stopped, lubrication would go on notwithstanding. It must be evident, that feeding from above, in all cases, involves the chance of dirt getting to the axle, which feeding from below obviates.

To provide against accidental injury to the axle-bearings, the writer provided also for a mode of shrinking on a false bearing upon the axle-arm, so that in case of cutting, it might be removed and replaced.

The following is a description of one of the axle-boxes, invented and patented by the writer, in May, 1837, employed on the North Kent line:—The top of the box is circular, for a peculiar arrangement of springs; the box is cast open-fronted, with a movable front to attach by screws; a grease-tight joint being maintained by an elastic substance between. In this mode the interior of the box can be inspected, and a new brass applied, without lifting the carriage. The back of the box round the axle is cast with a round-edged projecting lip. A plate of metal, with a centre hole fitting the axle, is secured by bolts to the back of the box, with a piece of leather, the orifice of which is enlarged into a partial pipe-form round the axle, to give increased bearing surface. This leather presses equally on the axle and on the lip of the box, and thus a tight joint is maintained, which preserves the grease without overflowing above the level of the bottom of the axle. The bolt-holes in the metal plate are oblong vertically; so that when the upper bearing brass wears, and causes a corresponding wear in the plate and leather, and a consequent leak below, the two latter may be drawn upward to fit the lower part of the axle. At the top of the box there is a screw tap for feeding, with holes through it, to admit of the ingress and egress of air. This tap serves to feed an upper chamber, having holes leading to the axle as usual, and also to feed the lower chamber, which, in addition, catches the grease that falls through from the upper chamber by the working of the axle. A piece of hard wood is applied between the end of the axle and the front of the box, to prevent the wear of the shoulder collar of the bearing brass. Two rollers of light wood float on the oil or grease in contact with the lower side of the axle, and thus carry up the lubricating material if it happens to be below the level of the axle.

The author next described an axle and axle-box, also for an upper and lower feed. To retain the grease or oil, a conical metal spring is inserted in a corresponding circular groove at the back of the box; and by pressing against a strip of leather lining the groove, it forms a tight joint. The small end of the conical spring clips a leather pipe-collar, fitted on the axle, which collar may either revolve with the axle in the small end of the spring, or may be fixed to the spring, and the axle revolve within the leather collar. As the spring expands against the groove in the box, it has no tendency to press the axle or leather too tightly, so as to cause friction. The conical spring is prevented from turning by a stud: the edges of the spring overlap each other, to keep out dirt; and the hollow space between the spring and the axle may be filled with sponge or cotton waste.

An axle-box on a similar arrangement, in which is a conical pipe of blocked leather, is secured to the box lip by an elastic ring, similar to a key-ring, and clipped to the axle by a second ring. Both the spring cone and the leather cone will, by their free action, accommodate any irregular movement of the box, and prevent loose wear between both them, the metal plate, and leather. In all cases where any material comes in contact with the revolving axle, it is essential that the surface be properly smoothed, that the pressure be as light as may be convenient, and the lubrication certain.

Distribution of Precipitation in Rain and Snow on the American Continent.

By Lorin Blodget, of Washington.

[From a paper read before the Scientific Association, at Cleveland, 1853.]

The most striking results of the discussion of the observations of the fall of rain on this portion of the continent, is the development of a *system of symmetrical distribution*. This most important condition may, therefore, be investigated in a much more effective manner than if the reverse were the case, as on the Eastern Continent, and generally elsewhere. We have a condition here very nearly reversing that of Europe indeed, in respect to the immediate inducing causes of precipitation, and this is necessarily associated with the distribution.

Precipitation by contact of saturated volumes of air with portions of the earth's surface has usually been considered the great inducing or initiatory process, and, therefore, excessive precipitation was found on hills and mountains, which offered abrupt contact with the saturated atmosphere from adjacent seas.

To generalize upon precipitation so induced or initiated, and from such sources of supply, would scarcely be possible, further than to refer it to the superficial atmosphere, and to these obvious causes. Such has been, to a great extent, the theory of precipitation and of supply of moisture to continents held hitherto.

Before going on to show the essential difference actually existing between this hypothesis and what really exists here, we may refer to some facts which verify it for portions of the Eastern Continent, and especially in England. An immense amount of observation has been made in England upon the fall of rain, and the general precipitation in every form. Yet few general or comprehensive deductions have been drawn, beyond the mere determination of its essential local character. Each district seems to stand by itself, and no one of these districts to illustrate another in any degree.

As a rule, however, so far as a rule of distribution may be considered as attained, the highest elevations have the greatest amount. This verifies the correctness of the hypothesis referring the supply to the lower volumes of the atmosphere, and looking no further than surface winds for the means of its transit from the evaporation of the precipitating surface.

That this, however, is a cause sufficient to produce the entire class of phenomena of precipitation in Europe, or even England, I cannot believe; but it masks the affect of more general causes so completely, that no attention has been given them. Districts, differing but moderately in elevation, have great differences in the amount of rain, in England. Further North, greater and more excessive amounts fall upon the heights, which break the Western Ocean winds. Eighty inches, or even a hundred, fall in some localities, and in Central England twice the amount on a hill, as compared with an adjacent plain, is quite common.

More abrupt contrasts still exist in Southern Europe—the region of the Pyrenees, and even in the Alps, and so predominating is this extremely irregular and diverse distribution, that the precipitation of the great area of North-Eastern Europe seems to have received no attention, if it does, in reality, present other conditions. There are many reasons for believing that that portion of the continent has many features in common with this in its character of precipitation and its sources of supply, but we are, as yet, without data to determine the point.

The first result of the grouping and comparison of the observations of precipitation on this continent, was the discovery of a general symmetry and correspondence in the amount reported at stations near each other, or in the same general physical relations of elevation, distance from the sea, and latitude. So complete has this symmetry proved to be, that graphic illustration of any single month's amount gave concentric areas of lighter shading from a maximum district outward, and a general beautiful proportioning of amount, without regard to any physical peculiarities of surface. In these charts of monthly distribution, the constants were scarcely apparent, and the maximum districts fill alternately in every part.

Next, *the absence of any increase in amount due to elevation*, became a most conspicuous determination. So far from the Alleghanies adding to the amount normally falling in the latitudes they occupy, they were found to give markedly less than the Ohio and Mississippi Valley, and less than the Atlantic coast, or any line of parallel observation. And this decreased amount seems to be fully as great as that due to the decreasing temperature of higher latitudes, as an elevation of 3,000 feet, giving approximately a decrease of temperature of ten degrees in the mean of any month, would have no more precipitation than a point far enough north to give the same mean temperature.

The Board of Commissioners of Public Works in Virginia, unwilling to accept the reported small supply to feed the navigable rivers of the State, placed guages at the opposite basis of the principal range of the Alleghanies, and the mean annual amount for four years is but thirty-six inches, while, for the same period, the Ohio Valley has forty-seven inches, and the plain of the Atlantic coast, forty-three, in the same latitude.

Equally decided is the elimination of local effect in every position in the United States, east of the Rocky Mountains, except, perhaps a portion of lake district in New-York, and some elevations in Massachusetts. The great fact, however, that the Alleghanies, as a whole, greatly diminish the amount of precipitation in the districts they occupy, though they exhibit fully the same symmetry and connection of the areas of various amounts, across their line, which prevail elsewhere.

The *mean annual distribution* preserves this symmetry and correspondence of adjacent stations and districts. It also discloses new laws of constant distribution, and points more clearly back to the primary sources of supply of moisture to the continents.

The general laws of mean annual distribution may be stated as having two rules of gradation, one of which is a *regular decrease of amount with decreasing temperature*, and the other, or concurrent rules, a *decrease of amount with increase of elevation*.

In accordance with the first, the maximum of this portion of the continent, east of the Rocky Mountains, is found near the Gulf Coast, and a regular decrease in this amount, in a right line, across the thermal lines northward. The remaining exceptions are the dry plains of Wisconsin, and the Ontario Valley in New York. The first of these may not be expected to accord entirely, even if its general law of distribution were as comprehensive as that which holds for the Continent eastward, for the reason that the very extraordinary conditions of the Pacific Coast and the Rocky Mountains must modify it, because of their new physical connection.

The other districts alluded to are less important anomalies, though sufficiently marked and decided in their character, as much as the driest portions of the continent, east of the plain for their temperature.

The general position, however, remains, and in accordance with it, we find an annual mean of nearly sixty inches of water falling at Natchez, and in Central Alabama and Georgia: *fifty-four inches*, thrusting its area further up the river, and toward the Atlantic coast; *fifty inches* reaching to Camden, S. C., and nearly to Cincinnati, on the Ohio, and to Muscatine, Iowa, on the Miss.

In this last direction, the mean of later years adds much to that first measured at St. Louis, and the correspondence of recent years of observation, at different places, is such that we cannot doubt it.

Concentric areas of decreasing amount thrust themselves northward from their maximum districts mainly, in accordance with these general rules. There is one exception, however, which should have been noticed earlier. It is a *decidedly less amount on the immediate coast*, especially in the South. This may be fully accounted for in the coast winds and cooler atmosphere of these localities, during the portions of the day most given to profuse precipitation.

We have, then, this remarkable reversal of previous generalization on continental precipitation, which gives us a *maximum line* in its *lowest and farthest interior*. The Mississippi Valley gives fifty inches, where the Atlantic coast gives forty-two, and the Ohio Valley gives forty-eight in latitudes where the Alleghanies give but thirty-six, and the Atlantic coast but forty-two.

This interior distribution is in part a law overruling the local effects so conspicuous in Europe and in the Pacific coasts, and in some degree itself anomalous. The amount falling on the Upper Mississippi and Ohio is too great for the rigid application of the rules here given. Iowa seems, indeed, to be a focus of excessive precipitation, in striking contrast with the plains westward, and with the lake country. It is intensely heated, however, and very low for a continental area so far in the interior, and it may be that a more extended series of years will remove a share of the excess in amount that seems now to belong to it.

These general facts of the distribution of rain on this continent, point, by the clearest induction, to a *source of supply entirely disconnected from the surface winds and surface atmosphere*. We have no gradations in amounts from oceanic districts towards the interior, but a law of distribution on this portion of the continent apparently disconnected from any oceanic considerations. Local areas of evaporating surface, also, if they influence precipitation at all, seem to *decrease* rather than *increase* the amount. Such is certainly the case about the great lakes.

The ocean winds which reach the continent here are few, and of little consequence in the amount of air they transfer. Prof. Coffin has shown the resultant movement of the surface atmosphere to be uniformly and markedly from toward the sea on the whole Atlantic coast to 35 deg. N. latitude. On the Southern and Gulf coast, the resultant for the year is also from the coast, computing the force and number of winds observed, and interpreting them into the actual volumes of air transferred. The violent and spasmodic winds from the land overbalance the longer continued, and aspiration from the sea and the trade wind becomes initiated in this belt of violent alternations, by the reduction of its movements to their mathematical resultant, before its regular and recognized development.

The southeast winds attending or preceding storms in the interior, are rarely or never continuous from the sea in that direction. They are as decided at Pembina, Minnesota, in lat. 49 degrees north, as at New-York, or Camden, S. C.; and in neither case bring saturated volumes from the sea to create a storm in the interior. This character of interior organization, and of procession backward of the surface winds, has long been understood in the case of northeast winds and storms. The two are precisely analogous, and though they may add in some degree to the amount of precipitation in general, and in severe storms particularly, they are never the inducing causes, and never give, from the volume of ocean air they bring, any considerable amount of precipitation.

The considerations necessarily connected with the phenomena of distribution render these positions clear. A storm commencing in the Mississippi Valley, and attended by both southeast and northeast winds, *while west winds are blowing on the Atlantic coast*, may distribute about Wheeling, as its maximum point, four inches in depth of rain, shading out to more at a distance of four hundred miles in every direction. It must be obvious that the immense amount had some great and general source of supply, in which the lower atmosphere and surface winds hold an entirely subordinate place. The distribution for each month, season, and year, presents the same comprehensive character, and refers necessarily to the same general and remote supply.

For this supply, we can see no cause adequate, except the returning equinoctial current, bearing with it an amount of moisture which it cannot sustain in the colder latitudes, and under the condensation to which this loss of heat and consequent descent of its volumes reduces it.

Descending as these volumes do, in successive and overlapping strata, and changing from southwest to west, over the belt of descent, the supply is uniform, and instituted at every point, though the conditions which may influence the time and manner of its precipitation may be quite irregular, and the solution of the problems respecting the initiating process and the attending forces extremely difficult.

The Great Exhibition.

Among the decided novelties in the way of mechanical combinations, none which are entitled to any claim to practicability deserve more notice than a multiplying gear applied to a horse-power, and exhibited in a somewhat obscure position on the right of the entrance. This new multiplying gear was patented by Frank Dibben and Louis Bollman, of this city, in August last, and the claim is published on page 229.

The invention is susceptible of numerous modifications, all depending on a principle which may appear tolerably simple when properly explained. To obtain the first glimpse, the diagram, Fig. 1, is introduced, *a a a* representing a fixed ring, with internal gear, and *c c* a gear wheel, mounted loosely on the end of the crank *e f*. If by means of a universal joint, or otherwise, a rotary motion be communicated to the wheel *c c*, it will evidently travel around the interior of the ring *a a a*, and will revolve the shaft *e*, on which the crank, *e f*, is secured. The ratio of velocity depends on the relative proportions; so that if we enlarge the spur wheel *c c*, and shorten the length of the crank, *e f*, until the wheel *c c* is of nearly equal size with the ring *a a a*, the crank shaft *e* will revolve much faster than the wheel *c c*; and the device, properly arranged, becomes a multiplying gear, which may be of great service in many situations, and which is well worthy of study, if only as an exercise in familiarizing one with complex mechanical combinations.

Fig. 1.

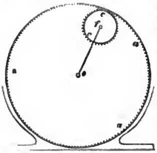


Fig. 2.

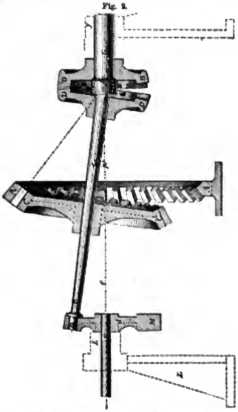


Figure 2 exhibits one of the forms of this invention, corresponding most nearly with our diagram above. A A is a fixed ring; E the shaft to which it is desired to communicate a quick motion, and G is the shaft through which the power is derived. The pair of small bevel-gear wheels D D and B B, with the ball and socket joint *e*, are equivalent to a universal joint for transmitting the rotary motion of G to the shaft E c, on which is keyed the gear wheel C C, meshing into the internal gear on the ring A A. The shaft E c is supported, as we have already seen, at one extremity by the spherical end *e*, which rests in a corresponding socket in the end of the shaft G. Its other end fits loosely in the eye of the crank I, attached to the quick shaft E. M is a weight cast on the crank I to balance the weight and centrifugal force of the shaft F c and wheel C C, which shaft and wheel are necessarily carried around the line *e* with each revolution of the crank I. In this arrangement *the speed of the crank shaft E is to that of the shaft G, as the diameter of the wheel C is to the difference of diameters of C and A*, which in the engraving are as 5 to 1; consequently when G revolves once E revolves 5 times, and the arrangement becomes a multiplying gear, which multiplies the number of revolutions 5 times.

The form exhibited in Figure 2 may be now supposed to be changed by removing the ball and socket joint *e*, and the bevel wheels B B and D D, and substituting in their place the common arrangement for multiplying by internal gear. The multiplying efficiency of the whole combination may be thus materially modified; and it is but a simple step from this supposed case to the form delineated in Fig. 3, in which both the wheels C C and D D are fixed on a shaft, F c, which shaft is supported by being held loosely in the crank, as represented. If in this arrangement a rotary motion be given to the wheel B B, the axis of the shaft F c will describe the surface of a cylinder instead of a cone, and all the wheels, whether internal or spur gear, will require to be plain, instead of bevelled, as before.

Fig. 3.

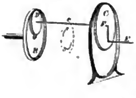


Fig. 4.

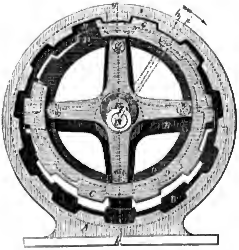
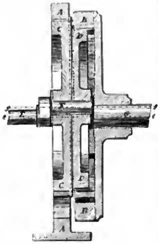


Figure 4 represents a side view and Fig. 5 a section of such an arrangement, the whole being compressed into a very limited space by contracting the length of the shaft *c* until it entirely disappears, and the wheels C and D become in fact parts of the same wheel, mounted on the crank pin of the crank *e f*.

Fig. 5.



A, the stationary ring, has 11 teeth on its inner surface; B, the internal geared wheel, keyed on the shaft G, has 10 teeth. Neither the slow shaft G, nor the quick shaft E, have any other motion than a simple revolution on their axes, the dancing, or rather waltzing, motion being confined entirely to the wheels or wheel C D. C is a spur wheel with 10 teeth, gearing into A; and D is another, having 9 teeth, gearing into B. It will be readily seen, that when the work is in motion the centre *f* of the wheels C D is carried in a circle around the centre *e* of the rings A and B, so that the teeth of the wheels will be constantly in gear, although the points of contact are continually changing.

The action of the pair A C is thus described by the inventors :—

The wheel C, having one tooth less than A, will, after one revolution of the crank (suppose in the direction of the arrow l), when the entire periphery of A has been in contact with the periphery of C, have revolved in an opposite direction to the motion of the crank, through the angular distance of one division of its pitch, so that the position of the line $f\,h$, will have changed to $f\,g$—the angle $h\,f\,g$ representing the angular motion of C, after one revolution of the crank.

This result is the same as if, both axes being stationary, the wheel A had made one revolution. It will be comprehended by referring to the action of the hunting tooth in common gearing.

We will now explain the action of the second pair, B D. Suppose that the wheel D is incapable of revolving in space, although its centre f is revolving with the crank, so that a line, $g\,k$, drawn through the centre f, of D, is in every position of the crank constantly vertical. The wheel B, being capable of revolving, will now turn in the same direction as the crank, the distance being also one division of its pitch; the line $e\,g$ will, therefore, after one revolution of the crank, be in the position $e\,i$; $g\,e\,i$ being the angular motion of B. But D being fastened to C, will not be in the condition we have above assumed. It will, by the action of the gearing, A C, as above explained, be revolving at the same time in an opposite direction to the angular motion $g\,e\,i$, of the wheel B, consequently the real motion of B will only be the difference between these two opposite motions, which is represented by the angle $h\,e\,i$. Let $a\ b\ c\ d$ represent the numbers of teeth, or the diameters of the wheels A B C D, then *the relative speed of the wheel* B *and the crank is represented by the following proportions* :

Angular speed of B : angular speed of crank :: $bc - ad : bc$. Substituting the numbers of teeth in our example, we obtain $10 \times 10 - 11 \times 9 : 10 \times 10 :: 1 : 100$. Consequently the crank E will revolve 100 times when B revolves once.

It is superfluous to say that the same combination which serves to multiply speeds may be used (by reversing the conditions with regard to the points of application), to "multiply power," as it is generally termed. Thus, when it is desirable to increase the number of revolutions, as in the full-size horse power on exhibition, a ratio of 100 to 1 is obtained within a compass of about 15 cubic feet, the strength of all the parts being designed for the action of two horses. But, if desired to act as a crab, or wheel and axle, for increasing "power," it is necessary simply to apply the power to the quick shaft, and take it off from the slow one.

Fig. 5.

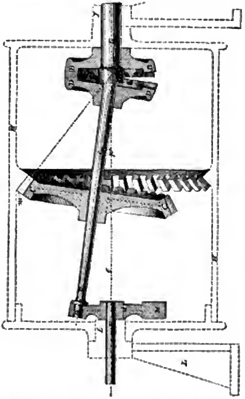


Fig. 5 represents a form designed for hoisting. In this application of our first modification, the wheel B is made stationary, and the ring A (instead of being, as before, provided with lugs for holding down upon a fixed object) is cast on the inside of the barrel H H (shown in dotted lines) of a hoisting apparatus. The barrel is free to revolve on the supports L, J, the shaft G being keyed firmly to the support J. The power being now applied to the crank-shaft E, which passes through the support L, the ring A, and with it the barrel, will turn in the same direction as the crank, the difference in speed being in this case 1 to 6.

The combination is capable of an infinite variety of modifications, several of which, besides those described above, have been constructed by the inventors, who will furnish further information and drawings to any parties interested in geared machinery.

The disadvantages are, that the strain on the parts are, in some cases, more severe than on the corresponding parts of ordinary gearing, and the tendency to vibration of the machinery cannot be completely balanced. The vibration arises from the fact that a heavy mass of matter revolves bodily around a centre, which centre does not coincide with its centre of gravity. The centrifugal force arising from this cause must, we imagine, be a serious, and probably the only serious objection to its introduction. In Fig. 5, assuming the centre of gravity, or rather the centre of gyration of the wheel C and shaft F e, to be in the centre of the shaft F e, it is evident that the centrifugal force will be equally felt on the equidistant points f and e'. Now the weight M on the crank I is supposed (if nicely adjusted) to very nearly balance *that part* of the centrifugal force which is felt at that end of the shaft F e, but another (and by supposition an equal) portion is felt at the other end e', and this is not balanced, nor can it be, by any means which the inventors have shown, or which occurs to us at this moment. It can be reduced to a minimum, however, by so constructing the apparatus, that the centre of gyration shall be as near as possible to the crank end of the shaft. To this end, it would be desirable, in Figs. 2 and 5, to shorten the throw of the crank I, and place it as near as possible to the wheel C. *If the boss on the wheel* C *were on its other face, and, in fact, the whole wheel dished, so as to allow the crank with its balance weight to be located in the plane of the centre of gyration of the wheel* C *and shaft* F e, *it might be possible to avoid altogether the tremulous motion of this species of mechanism, and cause it to work smoothly and steadily at any velocity.* The balance weight on the crank I should then be so adjusted, that its mass multiplied into its radius of gyration should equal the compound mass of the wheel C and shaft F e multiplied into *its* radius of gyration. If this suggestion is practicable, as we presume it may be, this method of multiplying velocity may yet become quite universal in its application to many useful purposes.

We have been betrayed into a greater length in treating this subject than we had anticipated, and must postpone the consideration of other objects of interest, till a future occasion. We would conclude, by repeating the invitation to inventors and others, whether exhibitors at the fair or otherwise, to communicate with us, and arrange for engravings and descriptions of their inventions.

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For Appletons' Mechanics' Magazine.

Mechanics for Practical Men.—Strength of Iron.

No. 8.

The chapter on page 212 concluded with an observation from Mr. Mallet on the importance of providing extra strength in portions liable to corrosion. The principles we have already established sufficiently guide us in the modes of effecting this; regard must not only be had to the contact of dissimilar metals, or of the same in dissimilar fluids, but to the scantling of the casting and its parts, and to the contact of cast iron with wrought iron or steel, or of one sort of cast iron with another. Thus, in a suspension-bridge, if the links of the chain be hammered, and the pins rolled, the latter, where equally exposed, will be eaten away long before the former. In marine steam-boilers, the rivets are hardened by hammering till cold; the plates, therefore, are corroded through round the rivets before these have suffered sensibly; and in the air-pumps, and condensers of engines working with sea-water, or in pit work, and pumps lifting mineralized or bad water from mines, the cast iron perishes first round the holes, through which wrought iron bolts, &c., are inserted.

And abundant other instances might be given, showing that the effects here spoken of are in practical operation to an extent that should press the means of counteracting them on the attention of the engineer.

Resistance to Compression. The best authority on this point is Mr. Hodgkinson, whose experiments were very full and varied. The trials were mostly on small columns with circular bases. The resistance was found constant for a height less than once and a half the diameter of the base, from this to a height equal to three times the base, the resistance was less than before, but still remained constant; and for any height greater than this, the resistance decreased with the height. When the piece was higher than three times the base, the rupture generally took place by bending. The pieces submitted to experiment generally yielded by an oblique fracture, the upper part sliding off on the lower. The angle made by the plane of the fracture, with the axis of the solid, was constant, and equal to about 55

The strength was found to be in direct proportion of the area of the cross section. The measure, therefore, of the resistance offered by a solid to rupture, either by compression or extension, is that force which will rupture a sectional area of the solid represented by unity. The following are the results obtained by Mr. Hodgkinson. The mean of the experiments on hot-blast iron gave for crushing weight, 121,685 lbs. per square inch; cold-blast iron gave a mean of 125,400 lbs. per square inch. These were on short prisms, whose cross section was a circle; when the section was a square, or other regular figure, the resistance was decreased to 109,600 lbs. per square inch.

Table from Mr. Hodgkinson's Experiments.

Description of Metal.			Compressive Force per sq. inch, in pounds.	Tensile Force per square inch, in pounds.
Devon iron,	No. 3,	hot blast, . . .	145,435	21,907
Buffery "	No. 1,	" . . .	86,397	13,434
Do. "	"	cold blast . .	93,385	17,466
Do. "	No. 2,	hot blast, . .	82,734	16,676
Do. "	"	cold blast . .	81,770	18,855
Carron iron,	"	hot blast, . . .	108,540	13,505
Do.	"	cold blast . . .	106,375	16,683
Do.	No. 3,	hot blast, . .	133,440	17,755
Do.	"	cold blast, . .	115,442	14,200

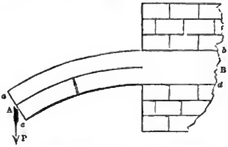
Resistance to a Transverse Strain.—The resistance of cast iron to a transverse strain is a subject of the highest importance to the engineer and architect. Indeed, to prove this, it is only necessary to point to the daily extending uses of this material in almost every possible shape, and it is well known that cast iron is seldom, if ever, submitted to any other than a transverse strain, as in cast-iron beams, girders, &c., and a strain of compression, as in columns, which will be investigated farther on.

The theory of the transverse strain has been fully investigated; and great numbers of experiments have also been made on this point, so that among mechanics the matter is considered as sufficiently settled.

The remarks below apply to other materials, as well as to cast iron.

Let A B be a body to which a force, P, is applied, in a direction perpendicular to the direction of the fibres. Supposing the force to be sufficient to bend the body, as in the figure, the fibres *a b*, on the upper side, will be extended, while those, *c d*, on the lower side, will suffer a strain of compression. This can be made evident; for by increasing the weight P, until a fracture takes place, the rupture will be found to commence on the convex side, thereby proving that the fibres on that side have been most extended; and, if some of the fibres on the convex side be separated by cutting them through transversely, it will be found that a smaller force than P will suffice to produce the rupture.

Fig. 1.



If, on the contrary, the fibres on the concave side *c d* be cut through transversely to a depth *m n*, corresponding to about half the depth of the piece, and a slip of hard material like a sheet of iron be interposed, so as to just fill the place cut out, it will be found, on subjecting it again to the force P, that the thin plate will be strongly retained by a pressure tending to compress it, while the strength of the solid will not be altered; the rupture commencing under the same strain, and in the same place as before. As we proceed from the convex toward the concave side of the solid, the extension of the fibres will gradually become less, until at a point at or near the centre of the piece, the length of the fibres will be found to undergo no variation. Beyond this distance, the fibres will be found to be more and more compressed, until we arrive at the concave side, where the compression will be at its maximum. The position of the fibres, whose form is not altered by the flexure, and represented by the line *e f*, Fig. 1, is called the neutral axis. Its position varies for different substances, but for practical purposes, may be considered to coincide with the centre of gravity of a transverse section of the solid

The fibres, whose lengths are not altered, are contained before the flexure in a plane perpendicular to the direction of the pressure, and which, of course, contains the neutral axis, as one of its elements. After the flexure, these fibres form a cylindrical surface, whose elements are parallel to the same plane.

Moreover, the fibres, at equal distances above and below this plane, undergo equal extensions and compressions.

In order to investigate the circumstances of a body submitted to a transverse strain, it is necessary to obtain the moment of the acting force, with reference to the points of support, and establish an equation between this and what is called the "moment of elasticity," when the deflection of the body is in question, and the moment of rupture, when rupture is the point. The investigation is conducted by the aid of the higher analysis, and would be of no use to the practical engineer, it is, therefore, omitted; all the results, however, being given in a form to be easily understood. These remarks apply to other materials, wood, &c., as well as to cast iron.

The experiments of Mr. Hodgkinson on cast-iron beams, the strength of best form for, &c., are the latest and most reliable authority on this point.

The following are the results of one of his experiments on bars of cold-blast iron, 5 feet long, distance between supports 4 feet 6 inches; the weight being applied at the middle of the bar.

Rectangular Bar, 1 inch deep, 1 inch broad.			Rectangular Bar, 3 inches deep, 1 inch broad.			Rectangular Bar, 5 inches deep, 1 inch broad.		
Weight in pounds.	Deflect'n in inches.	Set in inches.	Weight in pounds.	Deflect'n in inches.	Set in inches.	Weight in pounds.	Deflect'n in inches.	Set in inches.
16	·033		1082	·091	·003	4986	·110	·013
30	·062		1343	·111	·006	5867	·130	·017
56	·120	·002	1605	·138	·009	6798	.153	·020
112	·240	·007	1836	·164	·010	7730	·179	·025
168	·370	·014	2126	·190	·012	8662	·195	·030
224	·510	·028	2358	·220	·015	9593	·219	·034
280	·649	·041	2649	·250	·019	10525	·250	·042
336	·798	·061	2910	·281	·026	10588	broke	
392	·958	·084	3172	·310	·031			
448	1·120	·120	3483	·345	·037			
504	1·310	·170	3694	·378	·046			
514			3925	broke				
518	broke							
Ultimate deflection 1·36.			Ultimate deflection ·395.			Ultimate deflect'n 0.252.		

The strength of rectangular beams of any material varies,

as $\frac{bd^2}{l}$ in which b = the breadth of the piece.

d = " depth "
l = " length "

That is, that the strength of two pieces A and B are to each other, as $\frac{bd^2}{l}$ of the one is to $\frac{bd^2}{l}$ of the other. We will take an example from the table. A bar 54" long, 1" broad, and 3" deep, broke with a wieght of 3,925 lbs. To find what weight will break a bar, the same length and breadth, but 5" deep.

Let S = the weight which broke the first bar,
" S' = " " " second do.,
" b, d, and l apply to the first bar,
" b', d', and l' " " second do.,

Then from the rule referred to, we have this proportion

$S : S' :: \frac{b d^2}{l} : \frac{b' d'^2}{l'}$ Substituting the numbers

$3825 : S' :: \frac{1 \times 9}{54} : \frac{1 \times 25}{54} :: 9 : 25$ Reducing, we have

$S' = \frac{3825 \times 25}{9} = 10625.$ In the table will be found the bar represented by S', and the breaking weight by experiment is 10588, which varies but a few pounds from the rule. To take another case, let S' be 10' long, 2" broad, and 4" deep. Required the breaking weight. Here we have

$3825 : S' :: \frac{1 \times 9}{54} : \frac{2 \times 16}{120}.$ Reducing, $S' = 3825 \times \frac{32}{120} \div \frac{9}{54} = 6120$

This rule applies to any rectangular beam of any material.

The deflection of a rectangular beam, under a weight represented by P, varies as $\frac{l^3 P}{b d^3}$

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Apprentices' Department.

"In the World's broad field of battle, in the bivouac of life,
Be not like dumb driven cattle, be a hero in the strife."

NECESSITY FOR INTELLECTUAL EFFORT.

We have studied perhaps in vain for some method of impressing upon the younger members of the craft the imperative necessity of energetic measures for informing themselves, and placing themselves in a position far in advance of that attained by the generation before them in their earlier years. We would arouse the dormant faculties and enstamp a sense of their value upon the mind of their owners. We would do this as forcibly and effectually, but not as painfully, as future experience will be sure in time to effect it. If living and active, you will be certain to feel the want of all the training you can now so easily obtain.*

The men who are to wield the greatest influence in the world during the next fifty years, may be now driving the foreplane, the file or the sledge-hammer. The aristocracy of the schools has measureably departed. The idea that A. B.'s, A. M.'s, and other college-branded men hold a monopoly of useful knowledge, if it ever did obtain, is now pretty effectually removed, and if the prefix of Professor adds anything in reality at the present day to the claims of a devotee to practical science, it is only because the mechanics and workies, the really practical men, neglect in so great a degree the advantages which their situation affords, and are as a mass in a position, intellectually and socially, far below that which they may, should, and must ultimately attain.

The practical man is respected for his practical knowledge, but priding himself on this alone, he is too often as conceited as a mere college graduate, with, if possible, still less reason. He has, perhaps, still fewer faculties properly trained for the severe competition with his fellows, which forms in substance the realities of life. The apprentice drudges through his task of some ten hours' duration, sleeps perhaps six or eight more, and spends, in some form or other, of refined or unrefined idleness, the remaining fourth of every twenty-four hours. Omitting entirely the first day of the week, the proper mode of observing which may in this respect be a subject of controversy, the majority of young men without families, or even with, may obtain for mental culture time enough fully to initiate themselves in the elements of all the physical sciences, the only ones in which they may be directly and immediately interested.

Say not, in reply, that there is no need of such knowledge for the mechanic, that the greatest follies in mechanical art are among the scientific follies, and that the greatest humbugs which have puzzled and amused the world, were supported by a chain of Algebra or a profound series of logical syllogisms. "A little learning" is *not* a dangerous thing, except it is accompanied by foolish conceit; but, when so, it becomes a curse to its possessor and an annoyance to the world. If there is a pitiable object in existence, it is a scholastic fool, a learned—not an educated—dunce, who having in his memory the *language* and a faint glimpse of what he fancies to be the *meaning* of Newton's three laws of motion, looks down upon the unlettered as from the highest pinnacle of a temple. A smattering of science has often led to errors, but it argues nothing against our case, it is a strong point in our favor, as establishing the superior position of the educated mechanic. The man who has obtained the training both of the shop and of the school, the man who has had such opportunities and has drawn information from every source within his reach, is not a mere scholar, is not a mere laborer,—he is not a *mere* anything. He is the intelligent, educated, practical man, the man for every emergency, the man for the times.

But there is no just reason for being in this connection very severe upon the schoolmen of the present day. They have advanced with the times. There are at this moment preparing in the colleges and various institutions of learning in our country a set of men whose appearance a few years hence will tell most seriously upon the position of the idlers in the shops. Whatever the particular branch of business, the skill of the mechanic is susceptible of two great divisions—head work and hand work. The introduction of improved tools is every day lowering the value of simple manual skill, and the mere hand workie must assume, if not already in that position, the character of a machine—an expensive machine—only to be employed until a cheaper offers itself. The stage has changed since our grandfathers came upon it, and the colleges and schools have, to some extent, changed accordingly. But, although far ahead of the idle workie, they are and must be incapable of finishing *a man*. The *read* and the *well read* mechanic will, for practical purposes, be always preferred.

Let the mechanic then improve his time. He has every inducement to activity. Thousands of dollars and years of precious time are now spent in mechanical enterprises which might be saved and turned into useful channels by a little—no, by *much*—of the right information. There are, to be sure, serious faults in many of our mechanical books. The graduate still assumes to teach the mechanic much in which their positions might be reversed with profit, and many of the hot-house publications of the present age are but apologies for instructive treatises. Of this more anon; we are overstepping reasonable limits in this chapter. Mathematics and Chemistry are general matters on which there are excellent text-books at every corner. Algebra *must* be familiar in order even to read the treatises on practical subjects, and Arithmetic, Geometry, Trigonometry, Hydrostatics, Pneumatics, Hydraulics and Mechanics, do not need recommendation. Chemical art is every day becoming more important and further developed, but is not yet an exact science, and the books on the particular branch of business in which one is immediately engaged should above all be carefully studied. There are works of standard merit for almost all occupations procurable in almost every quarter, and, when not readily accessible, may be procured by mail without difficulty. Go in and win.

Answers to Questions on page 215.

20th. 425 lbs. is the weight when immersed in water.

Solution.—A cubic foot of wrought iron would in air weigh 7·8 times as much as a cubic foot of distilled water — 7·8 × 62·5 — 487.5. The water in which it is immersed would support it to an extent equal to the weight of a like volume of the fluid. Then 487.5 — 62·5 — 425.

21st. 3300 lbs.

Solution.—The whole anchor weighs 4500 lbs., *of* which the stock, weighing by supposition 700 lbs., and of equal density with the water, is of no effect whatever when immersed. There remains now (4500—700) an amount of wrought iron weighing in air 3800 lbs., of which is required the weight when immersed in sea water. First, let us ascertain the weight of an equal bulk of sea water, which must necessarily be proportionate to the specific gravities. 7.8 : 1.025 : : 3800 : 500. Deducting, then, 500 lbs. from 3800 lbs., leaves 3300 lbs., as the immersed weight of the anchor.

22d. The bladder *would* lose its buoyancy if forced to a sufficient depth beneath the surface of the sea. This depth may be found theoretically by calculating the pressure necessary to compress air with an equal density with sea water. Avoiding any attempt at strict mathematical accuracy, we may arrive at an approximation by a simple proportion. Knowing that the volume of a permanent gas is inversely as the pressure to which it is subject, or what is the same thing, the density is directly as the pressure, we require the pressure per square inch, which would make air as solid and heavy as sea water.

Spec. grav. of air at usual pressure.		Spec. grav. required.		Usual pres. of air.		Pressure required.
0.00125	:	1.026	: :	14.7	:	12066 lbs.

The pressure of salt water is about half a pound per foot of depth. The depth of immersion, necessary, therefore, to obtain the required pressure, is about 12066 × 2 — 24132 feet — 4.57 miles.

23d. We have received no answers, or even attempts at a solution. Will some of our active knights attack this difficult problem?

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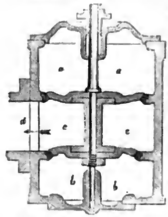
* See page 164 this volume, "Hints on learning without a teacher."

Questions.

The accompanying cut exhibits the construction and proportions of the common balance puppet valve, as used on American marine engines. It is an accurate section of one of the steam chests and valves of the steamship Humboldt, of the New-York and Havre line. This valve has many advantages over the various slides employed in the English engines, among which absence of friction, and consequent ease in starting or working by hand, is not the least. The absence of any injurious wear, the absence of packing, except in the stuffing-box at the top, and non-liability to scratches and injury from mud and grit, which sometimes comes over with the steam, are merits of no little importance in the practical working of large engines. Two circular valves, or portions of valves, are secured on one stem, so that both are elevated or depressed together. When the valves are closed, the chest is divided horizontally into three steam-tight chambers, the upper and lower being in communication with the boiler, and the middle being open on one side to the cylinder. The force of the steam, consequently, presses the upper portion of the valve down; but this pressure is balanced, or nearly so, by the pressure on the lower portion, which tends in an opposite direction.



Question 24. The diameter of the upper portion being 18 inches, and of the lower portion 17 inches, what force must be applied to the valve-stem to open the valve when the pressure of steam in the boiler is 18 lbs. above the atmosphere, and the vacuum in the cylinder 10 lbs. per square inch?

Question 25. The bevel of the valve seat being 30°, as represented, what is the area of opening or steam-way when the valve is lifted one inch?

Question 26. Supposing the whole properly adjusted, so that each bears equally firm upon its seat, what is the force pressing the two portions of the valve together, allowing nothing for the size of the valve-stem, and supposing the pressure and vacuum as in question 24?

◆

Monthly Notes.

Since the issue of our last number, the usual variety has diversified the field of view, with the exception, perhaps, of serious and extensively fatal accidents, which have been fewer than for some time previous. The steamboat law, which all unite in pronouncing far from perfect, has, it is hoped, induced a habit of greater carefulness. The steamer Bay State, plying on the Long Island Sound, between this port and Fall River, and every where known as one of the best boats in the Union, met with a somewhat unusual accident on the night of the 23d, having broken the crank-pin, while the piston was ascending, allowing the piston to be driven through the cylinder cover, and permitting a volume of steam to escape, which scalded several passengers in the upper saloon and state-rooms. The crank-pin was of apparently sound iron, 9 inches diameter, and was fitted in the drag-crank by a tapering end and bush. The shafts were probably out of line enough to partially account for the accident. The fracture was within the bearing, about one and a half inches from the shoulder, and crossed the axis of the pin nearly at right angles.

The steamship North Star (or steam yacht, as she has been generally termed) has returned from her European cruise, having arrived on the 23d, inside of 11 days, from Madeira. The North Star is a very creditable specimen of American steam engineering, and has in this cruise exhibited herself at Southampton, Copenhagen, Cronstadt (where drafts of the ship were taken by a corps of Russian engineers), Havre, Malaga, Leghorn, Civita Vecchia, Valetta (in the island of Malta), Constantinople, Gibraltar, and Madeira.

The North Star has two beam-engines of the usual construction for sea steamers, but finely finished. She left this port on the 20th of May last, and has, in the interval, steamed, in round numbers, 15,000 miles. Her trip is understood to have been at the expense of her proprietor alone, and in furtherance entirely of his own business and pleasure, with that of a few guests. The authorities at Naples are reported to have forbidden their landing at that place, not believing that any private individual could have undertaken such a tour, except with some great revolutionary designs.

The "Ericsson" is progressing, but not as rapidly as we had hoped. An accident, by which one of the cylinders was destroyed in the casting, has, of itself, occasioned considerable delay, not attributable to any peculiarity in the engines. Having nothing to add to our description of the new engines, as explained in our last (page 212), we turn to the consideration of other and less magnificent experiments.

An expensive series of experiments, costing in all a sum approaching $10,000, has been lately conducted in this city, by private enterprise, with a view to test the economy of mixing common with superheated steam. In other words, the experiments were on a mixture of steam and stame, generated separately. Our first volume treats at some length on the experiments on stame, or steam heated after its separation from water, as advocated by the late Mr. Frost and his coadjutors. A much greater expansion was claimed for stame than for common steam with equal increments of heat, and many experiments seemed to indicate the existence of the fact, if not the plausibility of any theory by which it might be explained. The late experiments alluded to, and in which several of our most skilful engineers have been employed, we hope soon to present in full, but at present feel at liberty only to indicate their general results. Steam alone, generated in an ordinary locomotive boiler, at a pressure of about 15 lbs. above the atmosphere, is used for three hours in a common stationary engine, non-condensing and inexpansive. The same boiler and engine are next employed three hours on stame of about equal pressure, and at a temperature of something like 420° Fahr. The steam is superheated by passing through a simple system of pipes in the top of the fire-box. The engine is next run an equal length of time on a mixture. It is found that, though slightly more effective, the advantage of stame over steam was not practically of any moment, but that a mixture of stame and steam, in the proportion of about three volumes of the former to one volume of the latter, produced an amount of work greater, by from 30 to 60 per cent., than either working alone. We have heard, as yet, no reasonable theory by which these apparent results are explained, whether choosing to admit or deny the reality of the improvement. We will only add to this faint outline, that the wrought-iron pipes for superheating have been found very little impaired by some three months of this severe usage.

Mr. Fisher has been for several months actively preparing a steam carriage, designed for Russ pavements or plank-roads, on a plan very nearly resembling that detailed by him in our last volume, and which may be soon expected to take the field (or rather the road), in competition with what he consider the "filthy and expensive horses."

Mr. Aspinwall, the well-known steamship proprietor, has lately constructed a small vessel of beautiful model, with a single feathering-paddle-wheel, encased in the heart of the vessel a little abaft of the centre. The wheel is about seven and a half feet long, six or seven in diameter, with paddles about eighteen inches in width, and dipping with their lower edges about eighteen inches below the bottom of the vessel. Two false keels serve to protect the wheel from damage in meeting the bottom. This experiment in propelling will be combined with a novel boiler, of small size but great heating surface, and other new features, so that the experiment will be somewhat liable to complexity.

But to return to motive power. The engine lately patented by Mr. Storms, the claims of which are presented in the June number, page 188, is now being tested by a series of careful experiments in the Novelty Works, in this city. Pure atmospheric air, condensed by a suitable pump, is admitted into a cylinder, until about one-seventh of a stroke has been performed, at which point the air is shut off, and steam admitted during another seventh, after which the stroke is completed by expansion. The inventor is very sanguine of realizing a great economy by this process. We have not learned that any decisive results, either *pro* or *con*, have been yet obtained from the experiments.

M. Du Trembley's engine, or combination of engines, working with vapors, volatile in different degrees, was briefly alluded to in our last number, as having been successfully tested in France. M. Du Trembley was here in 1851, and superintended a series of experiments at the Novelty Works, in which, as in accordance with any sound theory, a gain of considerable importance was realized under favorable circumstances. The plan was to generate steam, and work it off as usual through an engine, after which it passed into a vessel serving as a condenser, where its heat was abstracted and used in evaporating the ether or chloroform. This more volatile vapor was then worked off through another engine, after which it was condensed in tubes surrounded with cold water. The steam cylinder was 14 and the other 18 inches in diameter, the lengths of stroke being so proportioned that the ether cylinder was about three times the capacity of the steam. There were several difficulties; one of the most serious of which might be anticipated in theory, *i. e.*, the necessity of *abundance of cold*. In winter, when water at 60°, 50°, or even 40°, could be drawn from the river in any desired quantities, the apparatus worked with decided success; but with water at 70°, or warmer, the vacuum in the ether engine was quite imperfect, and the ether being itself warm, could but imperfectly condense the steam. In short, the engine was a good winter but an imperfect summer engine, according to theory. In practice, the condensers were very difficult to construct and keep tight; and a still more serious evil arose from the difficulty of obtaining a suitable volatile fluid. The vapor of ether was known to be so inflammable, as to be highly dangerous, and chloroform, although fulfilling the other conditions almost perfectly, corroded the metal to an extent absolutely prohibiting its use. We do not learn that many experiments were tried with different metals, but it is supposed that the vapor is decomposed to some extent by the process, and the chlorine thereby set free, which will unavoidably affect almost every material except glass.

It is presumed that these difficulties have in some way been removed, or possibly the danger of fire from the use of ether has been ascertained to be much less than anticipated. At all events, we have every authority for believing it soon to be applied to several steamers on the Mediterranean, when we shall be careful to report the result.

Mr. Donald McKay has now on the stocks in his yard, at East Boston, the largest clipper in the world. She is 325 feet long, 53 feet wide, and 33 feet deep, with four decks, and is between 6,000 and 7,000 tons stowage capacity. She will be launched, says the Boston Atlas, on the 4th of October, and will proceed to New-York to load for San Francisco.

Mr. R. F. Sturges, of Birmingham, England, has patented a process of ornamenting plain polished metallic substances, by compressing a material between two or more plates in the operation of rolling. The most delicate thread lace and perforated paper, are said to leave impressions on the surface to be decorated, of a depth depending on the relative compressibility of the two materials. Fine wire webbing might, no doubt, be used with fine effect.

Our August number contained an outline of the new French method of breeding fish artificially. M. de Quatrefages has since communicated to the French Academy some important researches on the artificial fecundation of the eggs. Assisted by M. Millet, he is stated to have shown that the temperature of the water for fecundation is a point deserving especial attention. The temperature varies for each species, and it is well to ascertain it for each separately. In general, for the winter fish, as trout, it is between 6° and 8° C. [43° to 46° Fahrenheit]; for the early spring fishes, as pike, 8° to 10° [45° to 50° F.]; for the later spring, as perch, 14° to 16° [57° to 61° F.]; and, finally, for the fishes of summer, as the barbel, 20° to 25° [68° to 77° F.]

The necessity of a specific temperature is connected also with the vitality of the spermatozoids of different species, which is of short duration, it not exceeding 8 minutes in the pike, whilst in man it lasts 8 hours. The maximum of vitality for the spermatozoids of the pike has been obtained at 85° F.; a higher temperature destroys them rapidly. The spawn of the pike is kept perfectly well in ice-water, and the spermatozoids perish only with a cold below —10° or —12° [14° to 10° F.]

This influence of temperature on the vitality of the spermatozoids of fishes, and therefore on the fecundation of eggs, presents a reason for the instinct which urges certain fishes to ascend streams, and at times to penetrate into rivulets, where they have hardly water enough for their movements.

M. de Quatrefages deduces some rules, which are important to the art of pisciculture, bearing especially upon the preservation of the spawn.

1. The water should not be supplied with the spawn in advance; it is well to leave the spawn in place even to the moment of employing it, and the fecundation should follow soon upon the death of the male fish.

2. Since the fecundation should take place within a day or twelve hours after the death of the animal, the spawn should be then taken and kept separate.

3. To preserve the spawn, it should not be placed in the water, or in the open air, but better in a moist linen cloth, which is kept at a temperature equal to, or a little below that which for each species gives the maximum duration to the movements of the spermatozoids.

4. If there are several fecundations to operate successively, it is necessary to detach for each the quantity of spawn required, and leave the rest in some convenient place.

To Readers and Correspondents.

The continuation of the article by Captain Ericsson has not been received. We invite attention, however, to an article on the same subject (pages 217 to 220, inclusive), which will be found still more complete and masterly than any which has yet appeared from any pen.

The paper applies the new theory of heat to both the air and steam-engine, with different proportions of the parts; gives the actual and relative efficiency of each pound of coal in the air and steam-engine, the proportion of the heat which is absorbed, utilized, or converted into work, in each engine, practically, with a careful calculation of the amount which it would be possible to utilize on the data furnished by Captain Ericsson.

Much data is given of importance, in connection with all forms of engines moved by heat. The paper will well repay the close attention which it requires. In turning back to the previous pages for the values of some of his symbols, it will be found that the Roman letter *r* was previously used to represent the ratios of specific heat, where the Greek letter γ (gamma) is now used, the latter symbol being more in accordance with general usage.

We regret the necessity of postponing to the next issue, number 4, of the able series on "Warming and Ventilation." Several other paragraphs of correspondence are also in type for the next number.

"N. B. Jr.," Maine. The fundamental points and lines are not yet fixed with any degree of certainty, and it must be impracticable to settle such questions as definitely as you seem to expect. The magnetic force varies in different places, even on the same parallel of latitude; and the dip of the needle also varies, and generally, but not always, in the same ratio. From a great number of observations in all parts of the world, lines of equal dip and lines of equal intensity have been traced on maps of the world, but these lines do not correspond with the common parallels of latitude, nor exactly with each other. Furthermore, these lines are not regular circles, and the exact location even of the magnetic poles can be known only approximately. Some investigators have found it necessary to suppose two, three, or more poles at the North, and an equal, or perhaps a greater, number at the South, so that the subject may not yet be considered as reduced to any thing like an exact science. Blind experiment will be as likely to get over your difficulty as reasoning. The latest work of any value on the subject is in three small volumes, by Sir William Snow Harris, styled "Rudimentary Magnetism."

"Mill-Wright," Va. We can recommend no better method than to relinquish the middle bearing altogether, and truss up the shaft so that it will support itself. Cast a light wheel, about four feet in diameter, and key it on the place of the central bearing, and connect by about one and a fourth inch bolts from the rim of this wheel to points as near as possible to the end bearings. A cross or star of hard wood might serve instead of a central wheel.

"Boston," Mass. Strictly speaking, the retarding force of friction in any engine consists of two quantities: 1st, the permanent friction of the unloaded engine; and, 2d, the friction due to the load. The first might be ascertained by trial with proper care, the second is estimated by De Pambour at 0·14 of the load. Bourne gives 1 lb. as the friction of a locomotive unloaded, and appears to depend on De Pambour's 0·14 for the estimate of the addition due to the load. McNaught found the friction of a 30 horse condensing engine to vary from 1·75 to 2·15 lbs., with a few feet of shafting. "Brown on the Indicator," gives 1 lb. as the friction of large engines, and 1·7 a small one. The assumptions of the *learned* authors are no authority at all. From 1 to 5 lbs. per inch is given in "Stillman's Treatise on the Indicator," as the friction of well-made engines, unloaded; very large ones rarely exceed the first amount.

"D. V. M.," La. Capt. Ericsson is styled "Mr." in Maj. Barnard's papers simply because the etiquette of the army and navy confines the application of complimentary titles to government officials; at least, that is our impression on the subject.

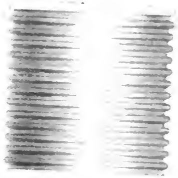
"Learner," Ohio. The greatest percentage of the full power of water ever obtained by any wheel and fully established by proof, was by a much simpler and cheaper wheel than yours could possibly be. The Atlantic Mills Co., Lawrence, Mass., admitted, in a suit with Uriah A. Boyden, C. E., that turbines built for them by the plaintiff yielded an effect of 90 [ninety] per cent.

"T.," Conn. Apply the test for water given in our July number. The only difficulty to be apprehended, from your description, is from the presence of vegetable matter.

CORRUGATED IRON BOILER

R. MONTGOMERY'S PATENT.

Scale: one inch to one foot



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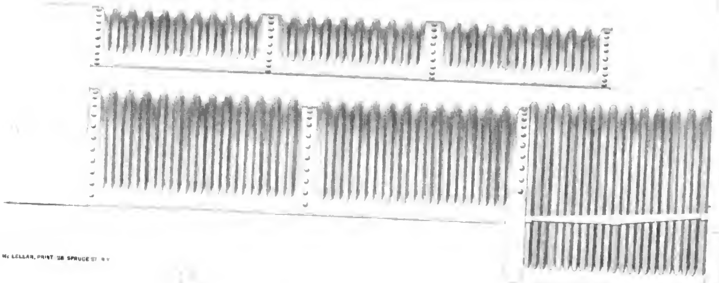

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APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 11.—Vol. III.—NOVEMBER 1st, 1853.

[To the Editor of Appletons' Mechanics' Magazine.]

THEORETICAL INVESTIGATION OF THE CALORIC ENGINE—Concluded.

By J. G. Barnard, Brev. Maj. U. S. Eng.

I have now to make some allusions to the "objections" set forth by Mr. Ericsson, in the August number of your Journal.

I have kept back this paper in expectation that he would make an end of them; but as he does not continue them, I must here dispose of what he has already advanced.

Unable, he says, to change the result of his computations by any other process, than by assuming a lower temperature than that on which they are founded, I select just such a degree as will bear me out in my argument, viz., 440°.

As he plainly tells me I am mistaken in this, I tell him likewise that the argument of my July number *is founded upon no such supposed temperature.* I have *used* it as a basis of calculation, and expressed my belief that he would not succeed in carrying a higher, and that, therefore, the power of the engines deduced from this temperature was a fair expression of their available power. But I have, in the course of the same paper, given him the benefit of a temperature of 589° (sufficient to place the cut-off at $\frac{3}{8}$th, where *he* places it, with a 12 lb. pressure) and a velocity of piston of 200 feet per second—both imaginary and unattainable; and have shown that, with such elements in his favor, his engine yet falls short by one-third of the necessary power, and requires an enlargement of cylinder diameter to 17 feet.

But while I make these concessions to him, I am firm in my opinion, that he cannot permanently carry a heat of materially over 440°, in the cylinder of the caloric ship's engines.

That he has *never* heated his air or his *cylinder bottoms* higher than that, I have nowhere asserted; and I have spoken, *not* of the heat of the cylinder bottoms, but of that of the air within; not of his model engines, and the results of temporary experiments, but of the *ship's* engines, and the temperature which can be carried, not for an hour or a day, but for a fifteen days' voyage, and a great many such voyages.

Does he pretend to claim that he can heat the mass of air in two or three seconds to 440°, without having his heaters, or cylinder bottoms, a great deal hotter than that? If he does, he claims what few will concede to him, without much better evidence then he furnishes.

The thermometers placed "in the centre of the opening between the regenerator and heater," are in an excellent position to absorb radiant heat from the heaters, and will, undoubtedly, keep their temperature up quite independently of the fluctuating temperature of the air within, which, at best, they could but imperfectly represent.[*]

The heat applied for melting lead may be applied as slowly and uniformly as desirable—the areas of the vessels are small—my argument neither applies to them nor is invalidated by them.

Mr. Ericsson has invited me "formally" to inspect the bottoms of the 72 inch trial engine, but he *has not invited* me, nor any one else, to inspect the bottoms of the caloric ship's cylinders, which are reported to have been burnt out, and which he states himself to have *yielded to an 8 lbs. pressure.*

I repeat, however, that the impracticability of his engine, as a marine engine, is not founded upon the assumption of 440°, nor any other particular temperature, or a fixed limit.[*]

Mr. Ericsson further remarks: "Reflecting practical men and engineers of experience express surprise at the tone of Major Barnard's last communication, in relation to the caloric engine, as it is evident to them he brings no other knowledge to bear on the subject than a general acquaintance with the laws of dynamics, and the knowledge derived from conflicting tables, showing the rate of expansion by heat, of the truth of which he knows nothing *prac-*

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[*] Take all the heating surface of the Arctic's boilers, and reduce it to radiant surface, and it will make about 8,800 square feet, which heats 1,010 lbs. water through 1,092° per minute, or each foot of surface transmits heat enough to heat 1 lb. water 125° per minute.

Now, take the case for which I have computed, viz., for a temperature of 500°, and 156 feet velocity of piston, or 13 strokes per minute, and it will be found that 650 lbs. of air are to be heated, as I have shown, 219°, by about 160 square feet of heating surface, requiring each square foot to transmit enough heat to raise one lb. water 211° per minute, 3-5ths more than the steam boilers transmit. This supposes the heaters to be acting *all the time* during the down as well as the up stroke; and there is no doubt that the escaping air in passing over the heaters receives as much heat as the inflowing air, which it deposits in the regenerators, and thus keeps up their temperature.

There can be no doubt that a more intense fire is required than under steam boilers, and that the impossibility of transmitting *this quantity* of heat is the main cause of the reduced pressure on the trial trips, though the bottoms were so highly heated, by Mr. Ericsson's statement, as to yield to an 8 lbs. pressure.

[*] My opinions on this subject are not only derived from the rapidly destructive effects of long-continued temperatures approaching to redness on iron, but on actual experience. Of Stirling's air-engine it is stated: "The greatest difficulty is in the proper application of heat to the outside of the air vessels.

"When applied directly by *radiation* from the fire to the spherical bottom of the vessels, it necessarily heated one part too much and another part too little, and the overheated part was not only liable to rapid oxidation, but by its expansion, the other parts were strained and cracked."

On this account it was found necessary to resort to another method of applying the heat. But in the caloric ship's engines, this very plan of heating, found impracticable by Stirling, is adopted; and in a manner to exaggerate the evils experienced by him. If unequal expansion and oxidation would crack, corrode, and destroy a heater of three or four feet diameter, will they not much more destroy one of 14 feet?

To my strictures on the engines of the *caloric ship*, Mr. E. incessantly brings up his *model engines* as a shield. I have broken no lances against *them*. I am willing to believe all he says about them. The failure of full-sized machines to perform what the models promised has been, before now, the fruitful source of disappointment to inventors.

tically. Major Barnard's entire criticism would lead to the inference, that nothing is accurately known, and that even the thermometer had never been applied to the caloric engine. What grounds there are for this supposition will appear in proper season."

My position is *precisely the reverse* of this; and I must, indeed, have "treated very clumsily" the subject, if I have given cause for such an inference.

My position is, that something *is* "accurately known"—that the laws of expansion of air by heat are known with all the precision that the most elaborate and oft-repeated experiments can give: experiments made by men long known and accepted as authorities by the scientific world. Such as Dalton, Dulong, Rudberg, Regnault, and others, whose labors were undertaken under the sanction of governments and scientific bodies in Europe, specifically and exclusively to the accurate determination of these very matters; and the results of which, as finally set forth in the reports of Regnault, possess all the perfection of accuracy, which can belong to the determinations of finite minds.

And, further, that the ratio of capacities for heat, of air heated under constant volume and constant pressure (which enters likewise as an element in my computations), if not known with the same perfect accuracy which characterize the determinations just mentioned,[*] is known *certainly* within well-ascertained limits, and that I have used the *extreme* most favorable to the engine in making these computations.

And as to the want of "practical knowledge" which he brings against me, it is quite in keeping with his sneers at "analytical absurdities" and "symbolical mystifications;" a charge not unfrequently resorted to by those who, conscious that their inventions are not founded upon any known theory or scientific principle, are loth to see them subjected to such tests.

This is to strike at the fundamental principle of scientific progress. That principle is, that the recorded experience of the past is the property of the present; that (in the present case, for example) the experiments of Gay Lussac, Dalton, Cavendish, De la Roche, Berard, Davy, Clement, Desormes, Marcet, Pouillet, Regnault, and many others, are our experiments as much as if we had made them ourselves, and are worth *to us* precisely what they would be esteemed worth *to themselves*, could any one of them (as those who still live *can*) survey the whole from our point of observation, that is to say, regard every one of the successive results, not as independent and competing candidates for absolute acceptance, but as having a value more or less weighty, according to the method by which it was obtained.

If later results are more valuable than earlier, it is because later experimenters began with what Mr. Ericsson denies to us, the *experience* (*their own* for all valuable purposes) of those who went before. If, in experimental science, tables *vary*, it is because they gradually approach more nearly to the absolute truth. As time advances, their variations are more and more inconsiderable.

If Dalton and Gay Lussac are, at present, less commanding authorities than Regnault or Magnus, it is because the last do not experiment without the methods and the results of the others before them; and because, therefore, as a mathematician might say, the modern results contain the former as implicit functions.

"Sitting at his desk," Mr. Ericsson is doing what he charges me with doing at mine—decrying the results of others, as he says I decry his—for his *assumption* of vast experience makes him not one whit more authority than I am. His *word* is good for nothing in the matter (no disrespect is intended); for no man's word is good for any thing in a matter of this kind.

Should electricians surrender all that they regard as established in their science (and their common sense along with it), because Mr. Henry M. Paine declares that electricity has been collected by him in a ponderable form? Should they not demand to *see* the operation first, and to be able to collect it themselves? To deny this, is to say that scientific truth exists only by the forbearance of knaves and the consent of fools.

Captain Ericsson *may* have the materials in his possession, collected during his long experience, which may entitle him to set aside the authorities of Regnault and others, and substitute his own, with their free consent and that of all the rest of the scientific world; but on a view of the whole case, the chances seem be otherwise; and till he *exhibits those materials*, to ask to be accepted as an authority, on the evidences of his own bare assertion, is a presumption which will find no favor, unless with those who are so entirely strangers to science, that their opinions are of no value.

The difference between the acknowledged authorities and Capt. Ericsson would, moreover, have still to be considered and weighed, even were his experiments and their methods published; nor even then could his results be admitted, until his processes had been repeated by impartial men. This difference consists in the fact that, whereas he, in all his inquiries, has been under the influence of one controlling desire, intention, purpose, determination, to compel the laws of nature to sanction a favorite scheme, *they* have been disinterestedly laboring with an honest and simple and sincere wish to discover the truth.

But even the very rigor and severity of exactness with which they have pursued their inquiries,[*] are made by Mr. E. the subject of something very like a sneer, while he magnificently alludes to the thousands of tons of air which he has heated. A fire on the mountain has heated millions of tons for Mr. E.'s thousands, but what has it taught us? The most ignorant engine-man has heated, perhaps, more tons of water than Mr. E. tons of air, but will scarcely be accepted as an authority against Regnault, on the physical properties of steam.

Let us suppose Regnault, Poisson, and Pouillet, assembled in judgment upon Mr. Ericsson.

Would it add much to their confidence in his results to be told of the tons of air he had heated, even if he could prove that he had passed the whole atmosphere a dozen times through his cylinders?

If, besides this, they were permitted to know nothing, but that his vessels were so leaky as to defy his efforts to come (according to him) within 4 lbs. of the intended pressure, and his arrangements so injudicious that his thermometers were perpetually bursting from the effects of radiant heat—would it enhance in their estimation the value of his statements.

These somewhat extended remarks have been brought out by a sense of indignation at the entire tone of Mr. E.'s articles—not towards myself, but at his tone towards men of science and science itself. Like perpetual motion hunters (a principle which *his claims* for his machine indeed involves), and that class of lunatics who for nearly two hundred years, have been battering their skulls against the Newtonian Gibraltar; he strikes at the very foundation of science, and repudiates the only legitimate principle on which it can be built. To demonstrate that no man shall claim any thing as truth, which he has not individually proved, is a principle which can only be just in a state of society (which, perhaps, never existed) where nothing ever has been proved, or where nothing proved has been recorded, with its evidence.

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[*] Since writing the above, I find that the recent investigations of Joule and Rankine have fixed γ with great precision at 1·4094.

[*] The experiments were made with *dry air*, because *air*, and not a mixture of air and something else, was the substance to be investigated. But the same authority which has established the co-efficient of expansion for air has also established it to be the same for vapor, and, hence, that its presence cannot modify the result of atmospheric air.

The experiments were made on small quantities of air, because most accurately made and measured in that way, and we have yet to learn from the inventor of the caloric engine, that the law which applies to a small volume of air will not apply to a large one.

And as to the effect of vapor upon the ratio of capacities for heat, of air, under constant volume and constant pressure (the quantity known as γ), the mean tension of vapor in the atmosphere is stated by Péclet at 1-110th the total pressure, so that it cannot affect my results to any appreciable extent, even if, for it, γ is smaller than for air (as it probably is).

These remarks, too, will enable a correct judgment to be formed of the "opposing facts," with which Mr. Ericsson says he has such a formidable array to meet me, and will serve as a preface to my strictures upon those "opposing facts."

Temperature developed by compression.—It is one thing to use thermometers, and another to use them for a specific object, and in a manner to attain that object. The law of increased temperature used by me is not only founded upon the theory of such an authority as Poisson, but directly verified by the *actual experiments* by M. Petrie (apparently without knowledge of Poisson's formulas), and the results are given to the world by him in a tabular form; and still further confirmed by the modern experiments for determining the mechanical equivalents of heat.

The compression takes place in the supply cylinder, and it is *there* the heat is developed. Supposing the engine to make 10 revolutions per minute, the heat is developed in about one second of time, and continues its effect for two seconds longer—three beats of a clock in all. The supply cylinder is then immediately filled with cool air from without. Is it supposed that any marine thermometer, exposed for three seconds to a temperature of 60°, and the next three seconds to a temperature rising from 60° to 140°—and this fluctuation constantly alternating, will indicate the 140°?

The amount of heat that the air may lose in these three seconds, by conduction and radiation of the surfaces in contact with it (for it cannot radiate itself), must be so trifling as not to affect my results.

If the thermometer is placed *in the receiver*, it is very possible that, through loss by radiation of the iron sides, it may indicate a lower temperature than belongs to the compression; but this can in no way affect the truth of my formula, even if, by a refrigerator, the air was cooled to zero.

"A tyro," Mr. Ericsson, remarks "in experimental philosophy, would hardly think of making a direct application of tables of rate of expansion to the caloric engine, even if they were quite reliable, without ascertaining the effect of, and making allowance for, the effect of radiation, &c." Very true; and even a *tyro* (as Mr. Ericsson, appears to desire to exhibit me) *has done* it. Their effects were maturely considered before I gave my computations to the public.

In reply to my statement, that Mr. Ericsson's "assumption of 60° increased temperature is not established by either argument or experimental facts, and is not in conformity with the laws of developed heat established by others," he replies, "that the result of actual trial of many weeks' duration, with supply cylinders of 58 inches diameter, *has* established a mean temperature developed by compression, ranging somewhat above 60°,—varying slightly according to the state of atmosphere, radiation of the supply cylinders, modified by currents in the engine room, speed of engine, and other minor causes."

Here is an *experimental fact* with a vengeance—"A mean temperature of over 60°"—"varying slightly according to state of atmosphere," &c., &c., &c.

With singular perspicuity in stating an "experimental fact," he does not even give the tension to which the air was compressed; neither where he placed the thermometer, nor any means of ascertaining what this additional 60° expresses. This is not the kind of authority that is going to upset the results of Regnault and Poisson, nor even those of a mere "tyro." I shall repeat, not as a "braggart assertion," but as a result of the theoretic investigations of Poisson, and amply confirmed by the *actual experiments* of Petrie and others, that atmospheric air at 60°, compressed in Ericsson's supply cylinder to a tension of 27 lbs., will have an increased temperature of upwards of 80°, developed in it during the two seconds of complete compression; that it will not lose by radiation or other causes, in *this period of time*, any sensible portion of this increase—that this increased temperature will be but insensibly modified by the hygrometic condition of the atmosphere, or "radiation of the supply cylinder"—and not at all "by currents in the engine room, speed of engine, or other minor causes."

And I further state that any falling off from this temperature, which may be indicated by a thermometer *placed in the receiver*, will have *no effect upon my formulas.*

"Maj. Barnard," Mr. E. says, "instead of admitting that in his original calculations he had committed the error of not estimating the increase of volume furnished by the supply cylinders, nor the consequent *increase of mean resistance* against the supply cylinders, now charges me with the monstrous fallacy of viewing that increase as an increase of power." "Can he point out any where, in my estimate, that the said increase has been treated as power?"

"In order to show the magnitude of the oversight in question, I stated the additional supply of air furnished to the receivers at 173·3 cub. feet per stroke, and *the force thereby exerted on the working pistons* to be 299.462 lbs. per stroke of 4 cylinders, &c."

And *I* stated that the *force thereby exerted on the working piston*, by this additional volume, to *be just no pounds* at all, per stroke. *This* is our essential difference.

And further, I *most distinctly admitted* the error of my "original calculations" (founded on Mariotte's law) in not estimating the increased resistance of the supply piston in consequence of this increased volume. To correct those errors, and exhibit the true law of pressure in the cylinders, was the *announced* motive for *continuing* the investigation.

And if the "monstrous fallacy" of claiming, as *power*, this 299·462 lbs. on the working piston (his "marked" deduction of the increased resistance of the supply pistons to the contrary notwithstanding), is not here distinctly repeated, there must be an astonishing misuse of words in this paragraph I have quoted.

Fall of temperature by expansion in the working cylinders, and assumed incapacity of heaters to restore the temperature.

Here is another of Mr. Ericsson's overwhelming "opposing facts" with which I am met at every step.

In exhibiting this "fact" to the reader, he has made no allowance for the effect of *clearance* on expansion (which, as it includes the regenerators and air passages leading to them, must be large). He has assumed the atmospheric pressure at 15 lbs. (instead of 14.725 or 14.71), which is near enough for general purposes, but not, in such a case as this, when a "fact" is to be tested, and for which the actual pressure per barometer should have been observed); and lastly, the accuracy of the data, as they stand, depend entirely upon his turning a stop-cock when the piston was just at a half inch of the end of the stroke—a nice operation. If this experiment were correctly* calculated, it would, as it stands, correspond very well

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* The amount of clearance has never been stated. The regenerators are about 15 cub. feet in bulk; allowing as much more for the air passages leading to them, and 9 cub. feet (something over one-half inch) for the "liberty" of the cylinder, and we get a total clearance of 39 feet, or three inches in the length of the cylinder. The cut-off was at ¾ or 54 inches, and the stop-cock turned at one-half inch from end of stroke, or 71½ inches. Adding 3 inches to each for clearance, and Mariotte's law requires 74½ : 57 : : 23 : 17.6. Poisson's formula gives the final pressure $P'-23\left(\frac{57}{74.5}\right)^{1.324}$ 16.185.

The *observed pressure* was the pressure of the atmosphere + 8 inches of to my theory and not at all to his; but, as it is a single isolated experiment, given without the precision necessary for a reliable result, and probably not undertaken with specific objects, it is perfectly valueless in every way.

Having, in a particular case, exhibited the pressure on the working piston as nothing at the end of the stroke, Mr. E. appears to imagine it a consequence of my theory that there can *never* be any pressure at that point, and brings up another particular case to oppose me.

With his usual partiality for his *model engines*, Mr. E. brings them forward with and without regenerators to prove the rapidity with which air may be heated; in the former case making some 60 revolutions per minute.

If Mr. E. will, with the dimensions and number of turns, inform me of the *resistance overcome*, I can calculate the number of degrees of heat communicated; but, without that essential element, I can neither calculate nor believe that 300° were communicated to the air, in the case he specifies.

But the fact has no bearing whatever on the question at issue. In these cases cited, the air flows over the heated surface; and I have not only admitted but calculated that their heaters *must* communicate upwards of 200° of heat[*] *in this way*, in the ordinary action of the engine.

But it is as to the heating of the air after the cut-off is applied, and when the *whole mass* is motionless, except the slight motion of expansion, that issue is joined. A heat of 120° has to be imparted, not in two seconds (as I first stated it) but in *one second*, and by no other means than "convection."[†]

Not only must the heaters act with as much rapidity to supply this 120° loss as they do while the air is flowing over their surface, but nearly *twice as fast*. It is scarcely worth the trouble to point out the inconsistency which calls the regenerators the principal source of heat in one breath, and then counts upon the heaters transmitting heat with this incredible rapidity.

I have again to repeat a statement, of which the truth is palpable to the common sense of every one, that the air cannot, after the cut-off, be heated the tenth part of what Mariotte's law requires, and something more than such "opposing facts" as Mr. E. appears to have at his command will be required to prove it unfounded.

I have not maintained that the air would not heat *at all*. I have no doubt it will receive heat enough to increase the final pressure somewhat above what Poisson's formula gives; but the formula is quite near enough, and I have used a value of γ which will more than compensate for any inaccuracy here.

But the most forcible comment that Mr. Ericsson has made upon the validity of my theoretical results, he has quite omitted. Lest he should forget it in his forthcoming category of "objections," I will now mention it. It is, that the engine which these results condemned without hesitation or reserve, as *worthless*, even while its triumphant success was every where proclaimed, was *abandoned* by the inventor, even before these conclusions were made public.

The machine, whose *perfect success* was announced only six months ago—"the most important invention of the age," after an effort or performance so feeble that it ought scarcely to be called a "trial trip," is now condemned as old iron.

There is no disguising or palliating the fact. *The* engines of the caloric-ship Ericsson, the final results of the inventor's 20 years' experience—the same of which glowing descriptions have been every-where circulated, over which the triumphant "Eureka" has been shouted, and on the construction of which a heavy outlay has been made, are found to be so utterly destitute of every merit claimed for them, as to make even modification or improvement hopeless; and others are substituted, whose only letters of credit will be the same promises which heralded the first.

And while thus admitting "practically" in the most forcible manner, the justness of the criticisms I have passed upon these engines, Mr. E. yet appears before the public in denial, and in bringing up "opposing facts." If he can find a fact strong enough to "oppose" to this utter abandonment of his own invention, he will indeed be fortunate.

"The history of inventions," to quote from Mr. E., "records many amusing instances of condemnatory opinions having been given against new inventions by those who knew less (perhaps) than the inventor; but" (to change his mode a little) "an instance of greater discrepancy between" promise and performance—of such total unmitigated failure as this invention has achieved, "can probably not be found," nor of condemnatory, theoretical opinions, so completely and in every particular confirmed.

Philadelphia, Sept. 8th.

I find it necessary to add, that the subject of the *maximum supply cylinder* is by no means thoroughly treated in what I have said in my former paper. To give it a thorough discussion would consume space and time unnecessarily, for the matter is now of little practical importance.

I have given my general expression for the effective mean pressure (equation 3, Oct. paper) in terms of the tension t; because, in the practical working of an engine, the tension (or pressure) of the air in reservoir, and the temperature, are the data most naturally observed, and given as elements of computation. Differentiating this formula, I have obtained an equation (equation 5), which gives the maximum supply cylinder for any assumed pressure.

But the counteracting force at the end of stroke is the real function which limits the increase of power, and a determination of the maximum supply cylinder should have been made in reference to that. Now, this function considered in its *relative* magnitude to the total effective pressure, depends exclusively upon l, or the cut-off.

Hence, the proper proceeding would have been to have given $P^t - p$ in terms of m and l, and to have differentiated regarding l as constant, and assumed such a value for l as would allow but an admissible counteracting force (*an absolute* maximum would be obtained by varying both m and l; but as it involves too small a value for l, it is of no practical use).

But we may obtain the required result from the equation of maximum (5) already given. This gives us the size of supply cylinder for *any* assumed value of t.

In the computation I have given immediately following for $t = 27$, m becomes very nearly 0·75, and l would be (from expression $l = 15\frac{m}{t}\text{ A}$) $=$ 0·77 about.

If we call this value l' and substitute in the equation (5) the value of t resulting from it (viz., $t = 15\frac{m}{l'}\text{ A}$) we shall obtain the value of m for maximum power with this value of l, and consequently with the *same relative counteracting force*. This would give a value of m nearly equal to 1, and a power of about 108,000 lbs. The counteracting force with this cut-off is however too great, and with a longer cut-off, the gain of power would not be so great. The practical result however is, that a larger supply cylinder than 2-3ds is desirable, but that no practicable gain of power by means of it will alter materially my conclusions, while the real fact is, that with the present arrangement of the engines, no enlargement is admissible, for want of adequate heaters.

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mercury — (14.725 + 1½) lbs. = 16.225 lbs.—agreeing with Poisson's formula within 0.09, and falling short 1.375 of the pressure required by Mariotte's law; but the experiment is entirely too loose in its data to be of any value.

[*] The impossibility of getting over 8 lbs. pressure, as the trial trips, proves, however, that as actually constructed, they are incapable of communicating this quantity of heat.

[†] Mr. E. asks me, if there is not such a thing as "radiation" to assist "convection"—and in a previous place he speaks of air's "radiating"—apparently ignorant of the fact that, except very insensibly, air neither radiates nor absorbs radiant heat.

SUPPLEMENTARY NOTE.

I have made an allusion in note, p. 242, to the probable value of γ for steam.

Assuming the identity of the mechanical equivalent of heat, through whatever agent employed, which, I believe, is now a principle experimentally as well as theoretically established, in the modern theory of heat, it is easy to deduce the value of γ from my formula of, 2d col., p. 221, October number. For this purpose, I will put it under a more general form.

Going back to the equation for air,

$$M\cdot\frac{K\,p}{\gamma}=\frac{14\cdot725\,a\,l}{519\,(\gamma-1)}$$

For any other gas this equation would be

$$M'\cdot\frac{K'\,p}{\gamma'}=\frac{14\cdot725\,a\,l}{519\,(\gamma'-1)}$$

In which $K'p$ is the mechanical equivalent of 1 lb. (or 1 unit of weight) of the gas heated one degree under constant pressure; M' the mass of the volume $a\,l$, at 60°, under atmospheric pressure, and γ' the value of γ for this particular gas, the co-efficient of expansion at 60° (1-519), being supposed the same for all gases, as is very nearly the case. This equation may be written (calling P the atmospheric pressure per square foot, and a the area in square feet)

$$\frac{\gamma'-1}{\gamma'}=\frac{P\,a\,l}{519\,M'\,K'p}$$

But the identity of mechanical equivalents gives us $K'p=K^{A}_{p}\times S^{w}_{p}$: K^{A}_{p} being the mechanical equivalent of heat for air, and S^{w}_{p} the specific heat of the gas compared to air, *by weight*, under constant pressure.

Also $\frac{a\,l}{M'}$, or the volume divided by mass is $=\frac{1}{d'}$, d' being the density of the gas.

Making these substitutions, we have

$$\frac{\gamma'-1}{\gamma'}=\frac{P}{519\,d'\cdot K^{A}_{p}\cdot S^{w}_{p}}$$

But the specific "height" by *weight*, multiplied by the density of a gas will give the specific heat *by volume*.

Hence $d'\cdot S^{w}_{p}=S^{v}_{p}$: S^{v}_{p} being the specific heat of the gas compared to air *by volume*.

$$\frac{\gamma'-1}{\gamma'}=\frac{P}{519\cdot K^{A}_{p}\cdot S^{v}_{p}}$$

For air the expression will be (its specific heat being ·28775)

$$\frac{\gamma-1}{\gamma}=\frac{P}{519\cdot K^{A}_{p}\cdot 28775}$$

or dividing one by the other, and reducing

$$\frac{\gamma-1}{\gamma}\times\cdot28775=\frac{\gamma'-1}{\gamma'}\times S^{v}_{p} \qquad (1)$$

If, in the above, we put γ for air at 1·4094 (as determined by Rankine), and S^{v}_{p} for steam (Regnault), at ·295, we shall find $\gamma'=1\cdot396$ (nearly,) for steam.

This value of γ' may be applied to aqueous vapor, as it exists in the atmosphere; and as it does not differ greatly from 1·324, used by me for air, it shows that the existence of moisture in the air could not materially affect my results, even were the quantity much greater than it is.

But this value of γ cannot be applied to determining the varying pressure of expanding steam in the steam-engine, from the fact that a certain amount of steam condenses during expansion, and its latent heat is absorbed by the uncondensed steam, through the effect of which the observed pressures are found to be *greater* than they would otherwise be.

An assumed value of γ for steam of 1·1 I have found will give approximately the *real* pressures, assuming Pambour's statement to be well founded, that the pressure of saturated steam, after *expansion* in the cylinder, corresponds to that of saturated steam of the *same temperature*.

For I have found that the pressure of *saturated steam* of different densities may be expressed (above 212°) with considerable accuracy by Poisson's formula $P'=P\left(\frac{\delta'}{\delta}\right)^{1\cdot1}$ and that the temperature above 32 of saturated steam may also be calculated by his formula

$$\theta'=(491+\theta)\left(\frac{\delta'}{\delta}\right)^{0\cdot1}-491$$

A much more accurate formula is given, however, by Rankine, in Ed. New Phil. Journal, July, 1849, and copied in Franklin Journal, for Feb. 7, 1850, and one quite as simple, though not, perhaps, as capable of being used in a general formula for the working pressure of the steam-engine.

The relation expressed by equation (1), for the value of γ, for different gases, may be deduced directly from Rankine's expression for $K\,p-K\,v$, in London and Ed. Phil. Mag., June, '53. (Sup.)

The following symbols used in the foregoing analysis (taken from Rankine), not being familiar to most of your readers, I repeat their meaning in this place.

K^{A}_{p} (or simply $K\,p$) = mechanical equivalent of heat applied to air under constant pressure.

K^{A}_{v} (or simply $K\,v$) = mechanical equivalent of heat applied to air under *constant volume*.

S^{w}_{p} = specific heat of a gas, by *weight*, under constant pressure.

S^{w}_{v} = " " by weight, under *constant volume*.

S^{v}_{p} = " " by *volume*, under constant *pressure*.

γ = the ratio of the specific heat of air under constant pressure, to its specific heat under constant volume, or $=\frac{S^{w}_{p}}{S^{w}_{v}}$

γ has been assumed at 1·324 for air in my investigation, but it has been accurately determined by Rankine at 1·4094.

Errata.—In October article, p. 220, 2d column, line 23, "Call *m* the mass," &c., should be "call M the mass." (An important correction, since *m* is immediately afterwards used in another sense.)

Same page and col., note, three lines from bottom, "The work *done* to the heat consumed," &c., should be "the work *due* to the heat consumed," &c.

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On Brass Founding.

From the Practical Brass and Iron Founder's Guide, by Jas. Larkin. 1853.

Brass Founding, considered as a branch of engineering, is beset with a host of empirical rules and fancies, to an extent which naturally surprises the scientific practician, when he considers it with regard to the present calculating and philosophizing age. Every founder thinks he possesses the only true and orthodox system of producing first-rate castings, and, as a matter of course, every one differs from his neighbor in his routine of practice, without reflecting that the process admits as fully of a reduction to scientific rules as any of its sister branches of the manipulatory art.

It is scarcely necessary to observe, that excellence can never be attained in any art in the prosecution of which so loose a system is tolerated: *guess-work* will ever give chance results, productive only of inconveniences and objections, which a more systematic code of regulations would entirely obviate. The number of alloys of copper which come under the generic name of brass, as has been shown,[*] amount to a numerous family, and are of the greatest importance, not only to the engineer, but to artists generally, involving the use of the following different metals, all of which are required in a greater or less degree to suit the variety of operations where brass is indispensable; namely, copper, tin, lead, zinc, antimony, and, in some cases, nickel.

The first four of these metals are those in the greatest request for engineering purposes. The leading metal of this series, copper, was known to the ancients previous to the discovery of *malleable iron*, and was applied to all the purposes for which the latter metal alone is now used.

The word copper is derived from the Island of Cyprus, where it was first wrought by the Greeks. The best method of obtaining it pure, where extreme purity is an object of importance, is to dissolve it in nitric acid; the solution is then diluted, and a piece of iron introduced, upon which the pure metal is precipitated, any adhering particles of iron being readily removed by washing with dilute sulphuric acid. Another method has lately been discovered of purifying copper, namely, by melting 100 parts of it with 10 parts of copper scales (black oxide), along with 10 parts of ground bottle-glass, or other flux. Mr. Lewis Thompson, who received a gold medal from the Society of Arts, for this invention, says that, after the copper has been kept in fusion for half an hour, it will be found at the bottom of the crucible, perfectly pure, while the iron, lead, arsenic, &c., &c., with which this metal is usually contaminated, will be oxidized by the scales, and will dissolve in the flux, or be volatilized. Thus he has obtained perfectly pure copper from brass, bell-metal, gun-metal, and several other alloys, containing from 4 up to 50 per cent. of iron, lead, bismuth, antimony, arsenic, &c. The scales of copper are cheap, being the product of every large manufactory. Copper melts at a white heat, and by slow cooling may be crystallized. Its specific gravity is 9, nearly. It melts at a temperature of 1096° Fahr.

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[*] See table, p. 119, App. Mech. Mag.

The reduction of copper ore is made by several consecutive processes. The first is by calcining it, and, when the ore is sufficiently "roasted" to oxidate the iron which it contains, it is melted. The melted metal is, after a time, suffered to flow into a pit filled with water, by which it becomes granulated.

It then undergoes further heating, and what is called technically its slag (or scoria) is taken off, and it is allowed again to run off into water.

After these processes it is cast in sand, when it becomes solid, and in this state is called "blistered copper."

It is now fit for what is called the refinery, and undergoes an operation called *refining*, or *toughening*. This is considered to be an operation of delicacy, and requires great skill and care in the workmen. It is conducted to a furnace similar to the melting furnace and the object is to thoroughly purify the metal from any portions of oxygen, which is performed by adding charcoal to the copper, while it is in fusion, and stirring it occasionally, till it is judged to be pure.

Tin, or Bedil in the Hebrew.—The next metal on our list has also been known from the remotest ages. It is mentioned by Eleazar the priest in the book of Numbers, chap. 31st, verse 22d. All the other metals supposed to have been then known are enumerated in the same passage. Thus, lexicographers form *bedil*, "to separate," tin being a separating metal. This carries the knowledge and use of *tin* back 1500 years antecedent to the commencement of our era. The Phœnicians used tin, of course, in the erection and decoration of the temple of Solomon. Their brass was bronze; zinc had not then been discovered. We read of tin, also, having been got by the Carthaginian navigator, Himiles, from the Sicily Islands; they certainly present appearances of ancient excavations. Tin occurs, native, in two forms—as peroxide, and as sulphuret of tin and copper. The last is rare; the former constitutes the great source of tin, and, in its native mixed state with arsenic, copper, zinc, and tungsten, is called "tin-stone;" but, when occurring in rounded masses, grains, or sand in alluvial soil, is called stream tin. The metal reduced from the tin-stone forms *block tin*—that from the stream tin forms *grain tin*.

The greater part of the East Indian tin comes from Siam, Malacca, and Banca. The last place is an island near the southeast coast of Sumatra. The mines were discovered in 1711; in 1776 there were ten pits, which were worked by the Chinese on account of the King of Palimbang. One hundred and twenty-five pounds cost him only five rix dollars. The greater part went to Alinia, or was used in India.

Zinc.—Zinc is a metal whose extensive range of application is only now beginning to be understood. It is found in the state of oxide and sulphuret; its specific gravity is about 7·7; its fusing point is 773°, but at a temperature of 300°, it becomes extremely malleable, and may be rolled into thin leaves, or drawn into fine wire. One of its most valuable modern applications, is as a protective covering for iron, being the best known substance for this purpose. The purifying of zinc may be effected by melting the impure metal with *lead*, in equal parts, in a deep iron pot, stirring them well together, skimming off the impurities as they rise, covering the surface with charcoal to prevent oxidation, and keeping them in a fused state for three hours. The lead descends to the bottom by its greater density, and leaves the zinc above, to be drawn off by a pipe in the side of the melting-pot. This contrivance is the subject of a patent, granted to Mr. William Godfrey Kneller, in 1844.

Brass moulding is carried on by means of earthen, or sand moulds. The formation of sand moulds is by no means so simple an affair as it would at first sight appear to be, as it requires long practical experience to overcome the disadvantages attendant upon the material used. The moulds must be sufficiently strong to withstand the action of the fluid metal perfectly, and, at the same time, must be so far pervious to the air as to permit of the egress of the gases formed by the action of the metal on the sand. If the material were perfectly air-tight, then damage would ensue from the pressure arising from the rapidity of the generation of the gases, which would spoil the effect of the casting, and probably do serious injury to the operator.

If the gases are locked up within the mould, the general result is what moulders term a *blown* casting; that is, its surface becomes filled with bubbles of air, rendering its texture porous and weak, besides injuring its appearance.

Plaster of Paris is often used for a number of the more fusible metals. This material, however, will not answer for the more refractory ones, as the heat causes it to crumble away and lose its shape.

Sand, mixed with clay or loam, possesses advantages not to be found in gypsum, and is consequently used in place of it, for brass and other alloys. In the formation of brass moulds, old damp sand is principally used in preference to the fresh material, being much less adhesive, and allowing the patterns to leave the moulds easier and cleaner.

Meal dust or flour is used for facing the moulds of small articles, but for larger works, powdered chalk, wood-ashes, &c., are used, as being more economical.

If particularly fine work is required, a *facing of charcoal or rottenstone* is applied. Another plan for giving a fine surface is to dry the moulds over a slow fire of *cork shavings*, or other carbonaceous substance, which deposits a fine thin coating of carbon. *This*, when good fine facing sand is not to be obtained.

As regards the proportions of sand and loam used in the formation of the moulds, it is to be remarked, that the greater the quantity of the former material, the more easily will the gases escape, and the less likelihood is there of a failure of the casting; on the other hand, if the latter substance predominates, the impression of the pattern will be better, but a far greater liability of injury to the casting will be incurred from the impermeable nature of the moulding material. This, however, may be got over without the slightest risk, by well drying the mould prior to casting, as you would have to do were the mould entirely of loam.

The experienced find that the proper time for pouring the metal is indicated by the wasting of the zinc, which gives off a lambent flame from the surface of the melted metal. The moment this is observed, the crucible is to be removed from the fire, in order to avoid incurring a great waste of this volatile substance. The metal is then to be immediately poured. The best temperature for pouring, is that at which it will take the sharpest impression, and yet cool quickly. If the metal is very hot, and remains long in contact with the mould, what is called *sand-burning* takes place, and the face of the casting is injured.

The founder, then, must rely on his own judgment, as to what is the lowest heat at which good sharp impressions will be produced. As a rule, the smallest and thinnest castings must be cast the first in a pouring, as the metal cools quickest in such cases, while the reverse holds good with regard to large ones.

Complex objects, when inflammable, are occasionally moulded in brass, and some other of the fusible metals, by an extremely ingenious process; rendering what otherwise would be a difficult problem a comparatively easy matter.

The mould, which it must be understood is to be composed of some inflammable material, is to be placed in the sand-flask, and the moulding-sand filled in gradually, until the box is filled up. When dry, the whole is placed in an oven sufficiently hot to reduce the mould to ashes, which are easily removed from their hollow, when the metal may be poured in. In this way (as will be afterwards shown) small animals, birds, or vegetables may be cast with the greatest facility.

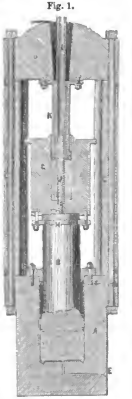
The animal is to be placed in the empty moulding-box, being held in the exact position required, by suitable wires or strings, which may be burnt or removed, previous to pouring in the metal.

Another mode which appears to be founded on the same principle, answers perfectly well when the original model is moulded in wax. The model is placed in the moulding-box in the manner detailed in the last process, having an additional piece of wax to represent the runner for the metal. The composition here used for moulding is similar to that employed by statue-founders in forming the cores for *statues*, *busts*, &c., namely, two parts brick-dust to one of plaster of Paris. This is mixed with water, and poured in so as to surround the model well. The whole is then slowly dried, and when the mould is sufficiently hardened to withstand the effects of the molten wax, it is warmed, in order to liquify and pour it out. When clear of the wax, the mould is dried and buried in sand, in order to sustain it against the action of the fluid metal.

Weems' Manufacture of Pipes and Sheets by Hydrostatic Pressure.

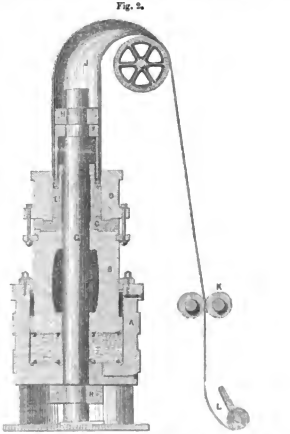
FIG. 1 is a sectional elevation of the modification employed by Mr. Weems in the manufacture of block-tin, lead, and composite metal pipes. The machine is entirely independent and self-contained, the hydrostatic pressure cylinder A, resting directly on the floor, without any other fixtures. This chamber is cast open at the top, and closed in with a bored cover, held down by set screws, the large water pressure ram B, working water-tight through this cover, which is fitted with a dished or cup leather ring for preventing the escape of water. The upper part of this water-chamber has also a deep projecting rib-piece cast on each side, and notched or recessed longitudinally at regular intervals, to receive the lower ends of the main wrought-iron tension rods C, which pass upwards, and are similarly inserted in corresponding notched ribs, cast on the two opposite sides of the main resisting cross-head, D, overhead. The water-chamber and cross-head are further connected by two vertical side-pillars, situated between the chamber top and the lower side of the cross-head, and recessed longitudinally to admit the tension rods. In this manner a very firm connection of the main details of the machine is obtained by simple means, both ends of the tension rods having solid heads, so that, when the rod ends are heated and slipped laterally into their grooves in the main castings, the contraction consequent on cooling causes the heads to form firm bearings to hold up the water-chamber and cross-head firmly against the ends of their side pillars. The interior of the water-chamber is lined with brass or copper, the escape of water behind which is prevented by cup leathers at top and bottom, and the lower end of the main pressure ram being expanded or formed as a piston, it has a pair of cup leathers and packing for the upper and lower sides. The port for the admission of the water from the force-pumps is at E, and a second port is formed above at F, for pumping in water above the piston portion of the ram, for the purpose of returning it downwards, when the charge of metal is exhausted. The metal, as block-tin or lead, to be used in forming the pipe, is contained in the traversing chamber or receiver, G, which rests on the top of the water pressure ram, B, and is held down thereon by a ring of bolts. These bolts have their heads inserted laterally into suitable holding slots round the bottom of the metal receiver, whilst their lower ends pass through a ring H, and are secured by nuts beneath—this ring being in two halves, and clamped into a ring groove formed round the head of the ram. The cylindrical core bar J, acting as the mandrel for shaping the pipe's bore, is placed accurately concentric with the axle line of the metal receiver. The fixed tubular piece, or stationary ram K, carrying the die or external shaping ring, is formed with a flange at its upper end, by which it is attached by the ring of bolts to the under side of the cross-head D. The external diameter of this tubular piece is slightly smaller than the bore of the metal receiver G, and its lower end is made with a shoulder, fitting exactly to the bore of the receiver. This shoulder, in conjunction with the inner ring of steel, forms the resisting pressure surface against the metal in the receiver. The actual shaping surface of this die ring is an inner shoulder, turned out of the ring, the bore of this shoulder being just as much larger than the diameter of the core bar J, as the thickness of metal of the intended pipe L, requires. The actual operation of this machine is similar to that of existing machines of this class. In commencing to work, the ram B, is let down to the bottom of its cylinder, and the top of the metal receiver G is then clear of the die above. In this state the receiver is charged with its supply of lead or tin, and the ram B, being then forced upwards by the pumping action, the surface of the contained metal becomes powerfully pressed against the die; and having no other means of escape, it exudes in the form of a pipe L, through the narrow annular outlet between the core bar J, and the shoulder of the die ring. But the essential distinctive feature of this system of construction is, that the core bar is fixed in the metal receiver, and therefore travels with it, along with the contained metal, so that there is no actual frictional contact except at the point of escape of the exuding metal; and the shaping die is pressed merely against the surface of the mass of *metal*, so that just so much of the mass of metal is caused to ooze through or between the die and core, as will produce the amount of pipe due to each increment of motion of the die, without, in any way, disturbing the rest of the metal, or giving rise to any frictional effect elsewhere.

Fig. 1.



In the core bar J, in Fig. 1, a small passage will be observed dotted in, entering at one side, passing up the interior of the bar to near the end, and then returning and passing out at the other side. This passage is for the circulation of a stream of cold water, to prevent the bar becoming too hot, when the metal acted upon is of a nature requiring it to be worked in a highly-heated state.

Fig. 2.



The machine, as constructed to manufacture sheets of lead or other metals, is represented in sectional elevation in Fig. 2. The hydrostratic pressure cylinder A, formed in the same way as in the other machine, rests upon an open base, and has fitted in it the large ram B, on the top of which the centre piece C rests, by a base flange being bound or held in one mass with the ram and the metal receiver D, by a ring of bolts passing through a flange on the receiver, and entering a ring let into a groove in the top of the ram. In this way an annular space is formed for the reception of the metal to be shaped, between the outside of the species of core piece C, and the interior of the metal receiver D. The metal receiver is, in this case, bored truly out to the outside diameter of the intended tube, which is made prior to flattening out in a sheet, so that the interior of the metal receiver is, in effect, the exterior shaping die for the pipe; whilst the pipe's bore is determined by the exterior of the core ring, recessed into and screwed against the end face of the fixed tubular core piece F. This fixed core die is entered upon a shoulder on the upper end of the main centre tension bar G, and is held down by a clamping collar ring H, made in two halves, to embrace a turned-out portion near the head of the bar. This bar is passed down through the centre piece C, the ram B, and the bottom of the hydrostatic chamber A, below which it is secured by a clamping collar H,—a thin wedge being placed beneath the end of the bar, to support and adjust it whilst the parts are being erected. In this way, when lead or other metal is supplied to the receiving space E, the upward pressure of the ram B, causes such metal to exude in the form of a pipe J, between the core ring and the interior of the receiver D. The metal so tubularly shaped may, therefore, either be used as a pipe of large bore, or it may be cut open longitudinally by a stationary knife, and gradually opened out by a wedge, and passed over a guide roller, and thence between a pair of nipping rollers, being finally wound up at L, in its completely flattened sheet state. When the thickness of the sheet is to be altered, the core die F is released and lifted up, and the shaping ring is removed by taking out its holding screws. A ring of larger or smaller diameter is then substituted, just as a sheet of thinner or thicker substance may be wanted. Again, when the bore of the pipe is to be changed, the receiver and core die are both to be removed, and larger or smaller details of the same kind substituted.

Various forms of receivers and pistons, or compressing details, are also proposed, for the purpose of making flat sheets direct by compression, without first making tubular pieces; the important principle kept in view, in all cases, being, as we before remarked, the concentration of the power employed upon the exact point of formation of the pipe or sheet, the material not being subjected to the slightest friction at any other part.

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Means taken to raise a Sunken Floor of a Warehouse at Mill-Lane, Tooley-Street.

By Edward L'Anson, Jun.

(Paper read at the Royal Institute of British Architects, May 16th.)

In the year 1849, Alderman Humphrey built a stack of warehouses at the bottom of Mill-lane, Tooley-street, from designs prepared for him by his architects, Messrs. Allen, Snooke, & Stock. That portion of the work which forms the substruction was carried on somewhat irregularly, and was directed in great measure by the Alderman himself. The builders were Messrs. William Cubitt & Co., of Gray's inn-road. The foundations of the piers and front wall, against the street, were put in entirely under the Alderman's own directions, so that whatever has taken place from defective construction reflects in no manner either on his architects or his builders. The warehouse is built in all respects with great solidity, and is a model for that description of building, being well lighted and substantial, and, although not wholly fire-proof, it is still very much subdivided horizontally, and is thus rendered much more secure than is usual in the ordinary construction of warehouse buildings. The erection of the warehouse, which on one side adjoins a dock now being formed by Alderman Humphrey, occupied about nine months; and here, before detailing the settlement to which I have to allude, and the means taken to remedy it, I propose shortly to describe the building itself.

The warehouse is, as has been stated, situated in Mill-lane, and is bounded on one side (the west) by the dock before referred to, on the east by the lane, on the north by another warehouse, and on the south the ground is at present vacant. The building consists of seven stories, including the basement. The roof is a simple well-constructed queen-post roof, of about 60 feet span; the height of the top story, from the floor to the under side of the tie-beam is 10 feet; the walls are 1½-brick thick in the recesses, and 2 bricks thick in the piers. The upper floor is constructed with wooden girders, having a bearing from centre to centre of the iron posts of 15 feet; the girders are 13 inches square; the joists, 12 inches apart, 12 ins. by 3 inches; and the bearing between the girders is 11 ft. 6½ in., or from centre to centre of the posts 12 ft. 7½ in.; the girders are supported by iron posts, to which I shall hereafter refer, and their ends rest on stone templates. The height of the story next beneath the topmost floor, from the top of the floor to the under side of the joists above, is 8 ft. 10 in.; the walls on this floor are 2-bricks thick in the recesses, and 2½ in the piers. This floor is constructed as a fire-proof floor, with arches 1 brick thick in cement, springing with a rise of 12 inches and a span of 12 ft 7 in., from iron girders, or springers; there is a layer of concrete over these arches, on which the floor surface is formed with asphalte; the abutment of the arches is stiffened by tie-bolts running longitudinally through the building, one in the centre of each bay between the iron story-posts. The construction of the floor next but one to the topmost floor is similar to that of the topmost floor; the walls are 2½-bricks thick, and the height of the story, from the top of the floor to the under side of the joists, is 8 ft. 9 in. The floor next but two to the topmost is fireproof, being formed of brick arches built in cement with a thickness of concrete, covered by an asphalte flooring, as already described for the floor next topmost floor; the walls are 3-bricks thick. The height of this floor, from the surface of the asphalte to the under side of the joists above, is 8 ft. 9 in. The floor next but three to the topmost floor, in ordinary parlance the first floor, is of timber construction, and similar to that of the topmost floor, except that the spaces between the joists are filled in with concrete, supported on a layer of slates fixed between the joists by wooden fillets. The height of this floor, from the surface of the floor to the under side of the iron springers, is 8 ft. 2 in., but under the centre of the arch, 9 ft. 2 in.; the walls are 4 bricks thick in the recesses and 4½ in the piers. The ground floor is paved with slate, bedded on concrete resting on the arches of the basement story, which arches are 9 in. thick, built in cement, and have a span of about 9 ft. 4 in., and a rise of 13 in. This floor is 9 ft. 10 in. to the under side of the girders, and 10 ft. 10 in. to the under side of the joists; the walls of the same thickness as in the floor above. The basement floor is paved with stone, and is 8 ft. 10 in. high under the centre of the arch.

The iron posts supporting the floors increase in size from the top of the building downwards; the caps are cast with the posts, and have a spread of 3 feet. The diameter of the upper story-posts (or rather the width of the web) is 8 inches, the metal web one inch thick, and the centre of the post is, I believe, hollow. The diameter of the lower story-posts is 11 inches, the metal of the web is 1¼ inch thick. The warehouse is thus divided into four horizontal compartments, which are, it is presumed, effectually fire-proof, and the compartment between the ground floor and first floor is further made more secure by the quasi fire-proof construction of concrete laid between the joists—a principle which Alderman Humphrey has carried out to a much greater extent in some of his other warehouses. The total area of each floor is about 6,656 feet, and the total cubical contents of each fire-proof compartment, including the thickness of the timber floor, is 133,000 cubic feet. The communication between the several fire-proof compartments is at present, and is intended permanently to be, by means of a staircase external to the building; but between the two compartments comprised between the fire-proof arches, it is by the usual internal ladder from floor to floor.

Before its completion, the warehouse began to show some evidences of settlement, which, as the loading was applied, gradually increased, until the settlement of the story-posts reached as much, in some cases, as ten inches, one of the first symptoms being the crushing of the arches springing from the piers in the basement. With the exception of the great defect of putting all the floors out of level, the building suffered no further damage than that the several brick arches, and particularly those in the basement floor, were all more or less fractured, and some of the stone templates in the wall were also split. The simple and efficacious means which have been used to rectify this defect is the subject to which I now call your attention. Simple and comparatively easy as the operation may appear, I know of nothing of its kind which has been more successful, and the experiment having been conducted on a scale of some magnitude, and with such satisfactory results, I have thought it might not be devoid of interest.

The warehouse having been relieved of all its contents, except on the upper floor, which was loaded all the time, the first operation was to remove the pavement of the basement, and to shore up the warehouse on that floor. For this purpose, four cast-iron girders, each capable of bearing a weight of 150 tons, were inserted through the piers under the springing of the arches, and these were effectually shored up by timber shores. The next step was to sink down to the foundations of the piers. Here the concrete was found defective and soft, but the great error seems to have been in not excavating the ground down to the gravel and placing the original concrete on it. In restoring the work this was however done. The first concrete was removed, and the ground below having been excavated, fresh concrete of Thames ballast and stone lime was put in, resting on the gravel. The thickness of the new concrete was from five to seven feet. The lower parts of the original brick piers, which were built in mortar, were removed, sometimes one and sometimes two at a time, the upper parts being carried during the underpinning by the iron girders, and the piers were rebuilt with brickwork in cement. These parts having been made secure, new arches of three half-brick rims were introduced under the original arches, springing from pier to pier, and on which the skewback which carried the floor arches of the ground-floor was cut. These arches were considerably crippled, and the springing line now shows, by its sagging, as it were, towards the middle of the building, how considerable a settlement has taken place, but it is now only in this part of the building that it can be observed. The floor arches were repaired and made good. The concrete covering was also partially removed, with the whole of the slate paving of the ground-floor. The concrete having been made good and brought to a level, the slate pavement was relaid. The foundation having then been perfectly secured, centres were fitted to the two end bays of all the brick arches above the basement, which was shored up, and one course of bricks was removed all along the crown of the arches which were shored; against the side walls of the warehouse the arches were cut through so as to leave them quite free and clear of the walls, the brickwork round the ends of the iron springers was cut away so as to leave the ends free, and all the bolts securing the caps to the wooden girders were screwed out and left loose. Stout uprights were then placed in the centre between each post from the basement arch to the under side of the iron springer of the first fire-proof floor, and twenty-eight screw-jacks of various forms and power having been procured, were fixed as close as they could be conveniently to the sides of the posts, and other strong uprights were placed above the jacks up to the under side of the girders on the top floor. A man having been placed to look out on every floor, the screwing commenced, by which at every effort the floors were raised from 1-16 to 1-8 of an inch.

The raising was thus effected of all the floors above the first floor, and gradually, as they rose, iron wedges were applied under the caps of the first floor, and also over the uprights between the posts This operation of screwing having been gradually carried on a little at a time, at intervals of a day or so, until the floors were raised as high as was considered safe, the screw-jacks were removed, and upright shores were placed against the posts, which were then left loose, and by the aid of two small jacks they were each got up, and stone and iron bases placed under them and well wedged up. When the whole had been made secure and firm, the brick arches were repaired and made good. The whole operation of screwing up, including the preparing for it, and making good after it, occupied two months. The jacks were worked two at a time, and there were sometimes ten men to one jack. The whole work has now been most effectually performed, and there are few traces (except the sunk line of the springing of the basement arches) to indicate the great settlement which took place. The restoration has not, however, been carried out with mathematical precision, and it has been thought necessary to introduce some iron wedges between the iron caps and springers, and to make doubly sure, the wooden girders have had an extra camber given to them, and are blocked up with wooden blocks on the iron caps.

The warehouse has been carefully and fully tested, and there is no further evidence of settlement or giving in any direction. One thing which is particularly instructive in this failure, is the fact that the foundation of the flank wall, which was built at the same time as the foundations for the story-posts, and is carried down to the same level, has not sunk. Another instance of the necessity of making the foundations for story-posts and columns stronger than the continuous foundation of a wall, once came under my own observation, in the case of the enlargement of a warehouse, where the flank wall, which had stood perfectly well having been removed, and the warehouse enlarged by building another flank wall removed further out by one bay, a range of posts was built on the foundation of the old wall, every one of which failed.

I had intended here to conclude my remarks, but finding by the circular convening the meeting, that the whole evening has been assigned to me, I have thought it would not be unacceptable if, while treating this subject, I brought under the notice of the members the most recently constructed and perfect warehouse in the London Docks. The great point aimed at is evidently to make the girders strong enough; they are double the thickness (or nearly so) of those generally used, and are trussed with wrought iron, which I am informed by Mr. Nesham, the resident architect, is never taut in the first instance, but only assists in case of the girders sagging. The size of the girders is 13 by 24 inches, in double flitches bolted together; the bearing of the girders between the centre of the posts is 11 ft. 6 in., the bearing of the joists between the girders is 10 feet; the size of the joists is 11 by 3 in.; the distance apart is 11 inches; the caps to the iron posts are 3 feet long; the suspending iron to the girders is 2¼ inches by 1 inch. I have had some experience in warehouse building, and I know that, next to the use of iron caps to the posts, the most important consideration is the making the girders strong enough. I have seen oak posts, which are occasionally employed, and were used universally until comparatively a short time ago, not only bent, but actually compressed nearly 1-10 of their substance. Mr. Nesham considers that 3 cwt. to the superficial foot is a fair weight for the loading of these warehouses, but that they might safely carry 5 cwt. As heavy a weight as a warehouse usually has to bear is a load of corn, which, for its preservation, is limited to three feet in height, the weight is about 1½ cwt. to a foot, and in the old construction of warehouses, where the extent of bearing was as near as possible 12 feet, it was always a maximum loading. Five barrels of flour weigh 2 cwt. to the foot; bags of sugar (eight or nine feet high) average about the same, or rather more, and, except fruit, there are few loads which average more.

The cost of these noble warehouses in the London Docks, built on a very indifferent foundation, was about £200 to the square of 100 feet superficial. The cost of Alderman Humphrey's warehouse was about £12,000 in all, or about £190 to the square of 100 feet superficial.

Discussion.—Mr. L'Anson, in reply to questions put by various members, gave some further information in reference to the above warehouse, and Mr. Hesketh also furnished several particulars, from his own knowledge of the original construction of the building. Amongst the facts thus stated were the following:—The cost of the restoration was about £1,000. The extent of new concrete used in making good the piers was six or seven feet; that of the original concrete, which was found to be defective, had only been about 4 feet. It was not laid under the whole floor, but only under the walls and the columns. It was not made of blue lias lime, but of common stone lime, such as the Dorking. The foundation was entirely a new one; and independently of the nature of the soil, a difficulty arose from the fact that the original concrete for the piers was thrown into the pools of water which had collected in the holes dug for them. The basement had been finished nearly two years before the superstructure was begun, and the builder appeared to have almost forgotten the character of the foundation. The settlement had not been equal over the whole length of the building, but varied, the greatest amount being about ten inches. The foundation of the dock wall had been carried down to the clay below the gravel, but those of the other walls did not extend to within two feet of the gravel. Each pier stood upon its own distinct and separate foundation. Although the weight of the walls and roof was much greater than the pressure upon the piers, the foundations of the walls had remained sound and without sinking; this arose from the continuity of the bearing upon them, and the employment of inverted arches. The screw-jacks used in the restoration rested on balks of timber, and having a slight foundation of concrete. The weight upon each pier, when the warehouse was full, was about 200 tons; and there was no doubt of the sufficiency of the piers, the defect having been entirely in the foundations.

Mr. Hesketh, in reference to Mr. Alderman Humphrey's views on fire-proofing, and to the question of fire-proof construction generally, expressed an opinion that the common cast-iron girders and 9-inch brick arches, sanctioned by the official referees as fire-proof were not so in fact; the effect of the cold water thrown upon the heated iron being such as to cause the girders at once to crack. Mr. Braidwood did not allow his men to go into a building on fire which was chiefly of cast-iron construction. Mr. Alderman Humphrey considered that his plan of using slate between the joists, with concrete above it, was almost fire-proof; especially as it had been tested by a fire in one of his warehouses in Duke-street. In that case, however, the fire was entirely above the floor thus constructed, and never attacked it from below. He (Mr. Hesketh) was of opinion that it would not be found to resist a fierce fire at all.

Mr. Scoles stated, that one reason why Mr. Braidwood's men would not go into a building where iron columns were employed was, that in a wooden structure they knew by calculation how long the materials would take to be burned through; whereas there was the greatest uncertainty as to iron.

Mr. C. H. Smith called attention to the spaces between the joists in the warehouse in question, as affording peculiar facilities for the spread of fire. They, in fact, constituted horizontal flues, in which the draft was as great as in the flue of an ordinary stove. Mr. Smith suggested, that at certain intervals, a small box containing brick-dust, or some other incombustible material, should be introduced to stop the current of flame. The same evil existed in ordinary partitions between the upright quarterings. He believed it would have been better if more iron and less wood had been employed in the building, so as to render it less combustible. The great quantity of wood served as fuel, in case of fire, to heat the girders; and although the goods contained in such a warehouse might produce the same result, it should be remembered that all goods were not equally combustible.

Mr. Inman (the chairman) observed, that the reason why the materials were used in certain proportions was to be found solely in the will of Mr. Alexander Humphrey, who had most honorably exonerated both his architect and builders. The nature of cast iron was well known. The Great Exhibition building was indeed a "Crystal Palace;" for iron was, in fact, crystal. It was crystalline in its construction, and liable to the same accidents as glass, and neither material would stand unless properly annealed. He considered the primary fault in the warehouse in question was that the foundations were not continuous; they were at various levels, and not homogeneous; the ground being hard in some places, and in others soft and moist. Attention to this point in the first instance might have prevented the failure. The measures taken to remedy that failure furnished a useful lesson, especially in the slow and cautious manner in which they were applied. The shortness of the iron stanchions in proportion to their diameter, and their arrangement in different sizes, according to the weight they had to bear, was a favorable point in the construction; and he trusted that the building might remain sound, though it would be difficult to vouch that it would be so. As to the strength of iron, it was desirable always to allow more than *double* the necessary strength. The meeting was much indebted to Mr. I'Anson for bringing the subject forward, because as much might be learned from failure as from success. Principles which were well known, were often omitted to be applied in practice; and the neglect could not be more strikingly displayed than where, as in the present case, a failure had resulted.

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On the Use of Compressed Air in Reverberatory Furnaces.*

With regard to the plan of working furnaces *with compressed air in closed ash-pits*, believing it destined to play a very important part in furnace management, I shall give a brief narrative of the steps by which I was led to a perception of its advantages. According to my ideas, its use will not be restricted to the burning of small coal, though this alone would give it a very extensive field of operations, but will extend to its general employment, as an adjunct to rarefaction in the stack, for furnishing the force required for producing the rapid rush of air through a fire, necessary for rapid combustion and intense and concentrated heat. By means of its assistance, the power required may be obtained at a much cheaper rate than by trusting entirely to rarefaction in the stack, which only produces a powerful draught, at the expense of discharging the products of combustion at a proportionally high temperature.

Although a great saving had been effected by the furnace with perforated sides, with the improvement of cleaning doors for keeping the perforations open, far from resting contented with what had been already accomplished, I regarded it rather as an earnest of future advances; and my notions of the state of perfection that ought to be attained were particularly dissatisfied with the fact, that whilst a great quantity of heat escaped to waste, the principal supply of air entered under the ash-pit bars *cold*. As there was ample waste heat for the purpose, why should not the *whole* supply of air furnished to the fire be previously heated?

Whenever I took any steps to effect this object in the puddling furnace, however, I encountered the fact, that precisely as my arrangements for heating the air became more perfect, did I destroy the draught through the fuel, deaden the fire, and lessen the yield of iron. This unexpected result I attributed to the rarefaction of the air in the ash-pit. When the atmosphere is at 60°, air is doubled in volume at 568°, a temperature below what is practically attained by causing it to circulate in contact with the heated bottom and sides of a puddling furnace. When thus rarefied, a much smaller quantity will pass in a given time, under the ordinary pressure of the atmosphere through the interstices of the fire-bars, than would pass were the air at 60°, and consequently of double the density, and the result is a greatly diminished draught, and less intense combustion; and it is to not having rightly appreciated these conditions, that the numerous failures which have been incurred in attempting to apply heated air to furnaces, must in part be attributed.

In puddling furnaces, the body or working chamber of the furnace, where the operation of iron making is carried on, and through which the products of combustion rush in their path to the stack, is freely open to the atmosphere at the working hole; and it is the air with its full complement of oxygen which enters at this aperture, which is principally instrumental in oxidizing and wasting, or, as the workmen say, cutting the iron: the air which has passed through the fire having yielded its measure of this gas to the fuel. When, therefore, we supply the ash-pit exclusively with air which is expanded to double its volume by heat, whilst, on the one hand, we have a greatly diminished weight of air entering the fire through the bars, and a less intense combustion, we have, on the other hand, the usual quantity, that is to say, under the new state of things, *double the proportionate* quantity of cold oxidizing air entering at the working hole, and hence the waste and poor yield of iron.

The desideratum in puddling, is to have so free a draught through the fire, as *to keep the body of the furnace full of flame*, and prevent as much as possible the indraught of cold undeoxidized air, through the working hole. A certain amount of exhaustion being created in the body of the furnace by the action of the stack, it is clear, that just in proportion as the products of combustion rushing from the grate are slow in supplying this void, will the quantity of cold air that enters through the working hole be increased.

That the quantity of air passing by the working hole, should form an influential element in the result attained, will not excite surprise, if we examine what this quantity may amount to, and how greatly it may vary. The application of a pressure gauge to the stack of a puddling furnace, shows a vacuum equal to ·24 of an inch of water, or a pressure of ·2 of an ounce per square inch, at which pressure the theoretical rate of influx is 39 feet per second; and consequently, supposing the size of the working hole to be 4 in. by 4 in., or 16 square inches, this would allow of 260 cubic feet of cold air entering the furnace per minute. Deducting 25 per cent. for friction, would still leave nearly 200 cubic feet as the quantity practically entering. The average quantity will however fluctuate greatly, as the relative pressure of the atmosphere acting through the grate bars or through the working hole, varies with varying currents of air.

I thus arrived at a clear perception, that to give the system of supplying the fuel with hot air the fullest development of which it was capable, it would be necessary to supply this air to the fire *under pressure;* but whether the benefits accruing would so greatly outweigh the expense and trouble of the additional appliances necessary, as to render its adoption advantageous in a pecuniary point of view, I was not prepared to say.

It was not fated, however, that I should remain long in doubt: I had yet to witness the operation of puddling in a gale of wind blowing in the direction of the working hole. Being in an iron work one squally day, my attention was arrested by a volume of oaths from one of the puddlers, whose furnace, being situated at the extremity of a rank, was particularly exposed to the wind, which blew directly into his working hole. With two large pieces of sheet iron suspended behind him, in the vain hope of warding off his adversary, he was laboring away in a state of great exasperation, and apparently to but little purpose. The dull red color of the iron showed the deficiency in temperature, and it was with difficulty it could be made to cohere into a mass. When the more violent gusts of wind came, so great was the quantity that entered the furnace, and so completely did it destroy the draught, that puffs of smoke were forced out at the ash-pit.

The workman himself was in much too ill a humor for conversation, but another puddler, who was standing by, observing the interest with which I watched the proceedings, addressed me, saying, "You see, sir, how very badly this furnace works; the man can hardly make his iron at all. Well, now, if the wind should change in the course of the day, and a nice steady breeze set into the ash-pit, this furnace will work as well as any furnace on the works; and this man's partner who comes on to-night, will do his work with comfort in two hours' less time, and perhaps make 1 cwt. more iron."

Now it immediately occurred to me, that if the *accident* of the wind's blowing into the ash-pit made such a difference, the same difference ought to be created *artificially*, and made *constant;* and concomitantly with this idea, I recognized the fact, that with the immense quantity of waste heat escaping by the stack, no fuel would be required for a steam-engine to compress the air, and that therefore the expense of the system would be restricted to providing the machinery, and keeping it in repair.

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* From a work just published by John Weale, London, entitled "Economy of Fuel, particularly with reference to Reverberatory Furnaces for the Manufacture of Iron, and to Steam Boilers, by T. Symes Prideaux, Esq."

The more I reflected on the subject, the more I became convinced, that whilst we were dependent upon the caprice of the wind for the working of our furnaces, we were in fact in a state of barbarism; and though such extreme cases as the one I have just related might not be very frequent, yet lesser fluctuations must be constantly taking place with every change of the barometer, making, in the course of the year, a large aggregate amount of loss from bad working. Indeed, that perhaps a more exact view of the case would be, to regard our furnaces as being constantly kept at work at a point of efficiency, far below what a little contrivance would enable them to reach.

Led as I had been by another path, and for another object, to contemplate the alternative of having recourse to the employment of *compressed air*, the subject had, of course, for me a peculiar interest, and I determined forthwith to examine it in all its details.

The result of this examination was, that the farther I proceeded with my task, the more agreeably was I surprised to find how completely, with many advantages peculiarly its own, it remedied the *defects* and supplied the *wants* of the present system; and I soon became impressed with the firm conviction, that it formed the only route by which we could ever hope to attain to a satisfactory point of perfection in furnaces where a powerful draught and intense heat are required.

To produce rapid combustion and an intense heat, requires a rapid current of air. The essence of the present system of furnace management is, to procure the power necessary for forcing, or rather sucking this supply of air through the fuel, from the levity (= heat) of the ascending column of gases in the stack. That there are many defects in such a system, is obvious. In the first place, the power of stimulating the combustion, being dependent upon the combustion itself, the capability of independent control is wanting, and energetic combustion can never be otherwise than gradually attained. Thus, after fresh lighting, it takes four or five hours to bring the puddling, heating, and melting furnaces used for iron, to a working heat. Not only so, however, but precisely at the moment when from opposing causes you require to spur on the action of the furnace, not only does such a power fail you, but the energy of the furnace languishes from the very cause which rendered a stimulus desirable. You get a reaction, but one in the wrong direction, and which allows the original evil to be reproduced in increased intensity. For instance; in the case of the puddler I have alluded to, the working of whose furnace was so much impaired by the wind blowing into his working hole, it would have been desirable to have removed the ill effect as quickly as possible, and lessened its power of recurring in the same intensity, by increasing the pressure of air in the ash-pit, and the fierceness of the combustion; but what actually took place, was, that the amount of cold air which entered the furnace at the working hole, reduced the temperature of the ascending column in the stack, and entailed, as a necessary consequence, a diminished draught of air through the fire, and an enfeebled combustion, just when the contrary condition of things was most urgently needed.

In working with compressed air, on the contrary, the action of the furnace *is always under direct control*, and can be heightened or diminished at pleasure; and in such a case as the one just referred to, by turning on an adequate current of air, the power of the wind acting in the adverse direction might be defied, and none of it allowed to enter the furnace; with the result of a saving of iron, of fuel, of labor, and of time. Indeed, in the manufacture of iron, the saving in the latter ingredient always entails that of the three former, and is, of all others, the most certain channel by which their economy can be attained.

Another advantage attendant upon a diminution of the time occupied in manufacturing processes is, that a smaller number of furnaces will turn out a given quantity of work, thus diminishing the amount of capital employed, and the expense of repairs.

The desideratum being to keep the atmosphere of the body of the furnace at a given intensity, with the least expenditure of fuel, it will not be difficult to show that the plan of doing so solely by *exhaustion*, by sucking, as it were, the heated gases from the fire rapidly through the furnace into the stack, is essentially defective; that under no point of view can it sustain, except at a disadvantage, a comparison with the contrary system of using compressed air as an aid to rarefaction in the stack, for promoting draught.

In one case we have the furnace *distended* with flame struggling to escape, and only discharged as it becomes forced out by the pressure of the volume of flame behind it; whilst a pressure being maintained above that of the atmosphere, no draught of cold air can enter the furnace, either through the work hole or any accidental fissure, to lower its temperature, or oxidize its contents. In the other case, on the contrary, the exhaustion operating through the neck, has a constant tendency to empty the furnace of flame, and, at the same time, to suck in cold air directly from the atmosphere through every available aperture, to the lowering of its temperature, and the injury of its contents. The very conditions on which the draught through the fire depends, necessitate a facile egress for the products of combustion because an independent power is wanting, to overcome the friction of forcing them through a more contracted orifice, the resistance, eddies, and commingling of gaseous currents, occasioned by which process, are so instrumental in making them yield up their heat to the parietes of the furnace, instead of carrying it into the stack. The larger the neck, and the larger the axis of draught, the larger the quantity of gaseous matter which darts in a straight line through the centre of the furnace, leaving little of its heat behind it, and imperfectly performing its duty.

Where an opportunity exists for substituting slack for best coal, by means of taking advantage of the stimulating influence of compressed air on combustion, the benefit in an economic point of view attending the use of air under pressure (amounting to a saving of half), is of course so great and decided as not to admit of dispute. I have endeavored, however, to show that it has more general and universal claims on our attention, than that of being merely regarded as an admirable instrument for slack burning, great, though these unquestionably are: in short, I wish to recommend it for general employment, as an adjunct to rarefaction in the stack, whenever powerful draught is required; maintaining that the combined use of the two offers a cheaper means of obtaining the force required, than trusting solely to the latter; and that whenever heat which might be otherwise beneficially employed, is dismissed into the stack for the *sake* of heightening the temperature, and consequently the draught, it is sadly misapplied, inasmuch as the hundredth part of it employed in raising steam to be applied mechanically, would be productive of a greater effect.

Before entering into any calculation on the subject, I *felt* that the having recourse to the comparatively inert power of gravity (through the ascending power of a column of heated air), must be a wasteful mode of obtaining the force requisite for producing the necessary draught of air through the fuel, when compared with the expedient of generating the same force, by the vastly more energetic power developed by the chemical law of vaporization (upon the addition of heat to a liquid), as in the case of converting water into steam. I was not, however, prepared for the actual results which presented themselves, viz.:—that 1 lb. of coals employed to raise steam, and applied in a steam-engine, will do the work of 500 lbs. expended in rarefying air, such air acting through a height of 35 feet, the elevation of the stack of a puddling furnace.

The force of the draught in a stack or chimney, is the *preponderance* in weight of a column of air of the area and height of the stack, and of the temperature of the atmosphere, over the column of rarefied air with which the stack is filled.

Now, since the air at 60° expands $\frac{1}{508}$ for every degree of heat imparted to it, when the atmospheric temperature is 60° (n), the number of degrees the air is raised in the stack above the external atmosphere, multiplied by (h) the height of the stack, and divided by 508, $\left(\frac{n \times h}{508}\right)$ will equal the height of a column of *rarefied air*, equivalent in weight to the deficiency in the stack, and $\frac{n \times h}{508 \times n} =$ the height of a column of air at the *atmospheric density* equivalent to the above. The rate of efflux, is the velocity a heavy body would acquire in falling this height, to find which, multiply the square root of the height of the fall, by 8, or in practice, to allow for friction, by 6.

One part of carbon, will raise 14.220 parts of water 1°, and if we estimate the specific heat of air at ·25, that of water being 1, then 14.220 × 4 = 56,880 parts of air raised 1° by 1 part of carbon.

Now, since the heating power of hydrogen is to that of carbon as 60,854 to 14,220, or about four-fold, if we estimate coal as composed of 80 parts of carbon, and five of hydrogen in the 100 parts, the 5 parts of hydrogen being about equivalent to 20 parts of carbon, we may calculate the heating power of coal to be weight for weight, the same as carbon.

Now the stack of a puddling furnace is 35 feet high, and we will assume the temperature of the ascending column of rarefied air to be 2,600°,—an estimate above the truth.

Supposing, then, that 1lb. of coal will raise 56,880lbs. of air 1°, it will raise 22·3lbs. 2,540°, and 2,540° + 60° for the temperature of the atmosphere = 2,600°, the estimated temperature of the ascending column of rarefied air in the stack.

Since air at 60° increases in bulk $\frac{1}{480}$ for every degree of heat imparted, at 2,600° its volume is increased six-fold, and the difference in weight between a column of air weighing 22·3lbs. at 2,600°, and a column the same size at 60°, will be 111·5lbs., and 111·5 × 35, the height of the stack, = 3,902·5lbs., the lifting force capable of being exerted through the space of a foot by 1lb. of coal employed in rarefying air, such air being transmitted through a stack 35 feet high; and supposing no loss to take place by friction, eddies, and progressive loss of temperature in the ascent. Deduct for these, the odd 902·5lbs., or 23 per cent., and we get lifting force exerted by 1lb. coals employed in rarefying air, such rarefied air being discharged through a shaft 35 feet high, = 3,000lbs. raised 1 foot. Now in some of the Cornish engines, the duty performed by 1lb. of coals is 500-fold the above, = 1,500,000lbs. raised 1 foot; or in other words, 1lb. of coals employed to raise steam, will do the work of 500lbs. expended in rarefying air, such air being discharged through a stack 35 feet in height.

The above calculation clearly shows that it is a sad misapplication of heat, to employ it in generating power through the ascending force of a column of heated air, and consequently, that whatever heat might be economically employed in other ways, is most prodigally wasted, when allowed to escape by the stack for the *sake* of draught,—a tolerably decisive fact in favor of the superiority of the system of ventilating coal mines by mechanical agency, as proposed by Mr. Brunton, over the old method of rarefying the air in a shaft by a fire at the bottom.

The best instrument for compressing the air for furnaces, where only a slight condensation is required, as in reverberatory furnaces and steam boilers, is a fan. Though theoretically making but a small return for the power expended, it is practically the most convenient, and half a horse power is sufficient for a puddling or mill furnace. And for such furnaces, the whole expense of employing the system of working with compressed air, is restricted to the cost of the machinery, since no expenditure will be incurred for fuel. On the contrary, the result of the adoption of the plan, is greatly to increase the quantity of available heat. Under the present system, heat sufficient to generate steam for about 5-horse power, is as much as can be subtracted from the flue of a puddling furnace, without injuriously affecting the draught; the flues of 4 furnaces being applied to a 20-horse boiler. By the assistance of compressed air, however, double this quantity may be taken with safety, so that the extra quantity rendered available by its application to one furnace, would suffice to furnish power to compress the air for ten.

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Static Pressure of Water under Different Heads.

A CONVENIENT and easily-remembered method of approximating to the pressure of water, is to allow one half pound pressure per square inch for each foot of head; the pressure at any point being directly as the perpendicular depth below the surface. This simple rule affords a ready method of ascertaining its amount with an accuracy sufficiently close for ordinary purposes. That it is not, however, strictly correct, may be readily perceived; and having occasion recently to calculate with tolerable exactness the pressure corresponding to several heads, between ten and one hundred feet, we present the following table for the convenience of others, having enlarged it by the addition of several numbers outside of these limits.

The temperature of the water is assumed at 59° Fahr. The density in consequence of the presence of salts and other foreign matters is assumed at 1·000149, distilled water being unity. This density, corresponding with the elaborate investigations of Boisgavand on the water of the Garonne, and with those of Brisson on the Seine, we have assumed as that due to the saltness of ordinary fresh water. An allowance should perhaps be made for the increase of density due to the compression of water under great heads; but this compression, although proved to exist, is too slight to be of any practical importance. Experiments on this point indicate a compression of about ·000046 of its volume under one atmosphere, or 22·922 inches of mercury.

Head in feet.	Pres. in lbs. per sq. in.	Head in feet.	Pres. in lbs. per sq. in.	Head in feet.	Pres. in lbs. per sq. in.
1	·43	85	36·83	5000	2166·
2	·86	90	38·90	6000	2600·
3	1·30	95	41·07	7000	3033·
4	1·73	100	43·33	8000	3465·
5	2·16	125	54·17	9000	3900·
10	4·33	150	65·00	10000	4333·
15	6·50	175	76·03		
20	8.66	200	86·67		
25	10·83	300	130·01		
30	13·0	400	173·34		
35	15·16	500	216·66		
40	17·33	600	259·02		
45	19·50	700	303·53		
50	21·66	800	346·69		
55	23·83	900	389·03		
60	25·9	1000	433·		
65	28·06	1500	650·		
70	30·55	2000	866·		
75	32·72	3000	1300·		
80	34·66	4000	1733·		

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LIST OF PATENTS

Issued from the U. S. Patent Office during the month of Sept., 1853.

M. W. Baldwin, of Philadelphia, Pa., for Gear of Variable Cut-off Valves for Steam-Engines.

Claim.—The arrangement of the sliding pivot block fitted with a stem, connected with the sector by straps, chains, or cogs, the hand lever, and the intermediate connecting mechanism, as described.

John Chilcott & Robert Snell, of Brooklyn, N. Y., for India Rubber Soles for Boots and Shoes.

Claim.—Constructing the whole, or any portion of the sole of a boot or shoe, as described, of India rubber, with the inside and edges covered and protected by leather, which is united with it by any water-proof cement, with or without stitching, and forms a hard, firm, leather edge.

John Chilcott & Robert Snell, of Brooklyn, N. Y., for Cutting Boots and Shoes. Patented in Belgium Sept. 16, 1853; in France Sept. 17, 1852; in England Sept. 30, 1852.

Claim.—We do not claim the manufacture of boots without crimping; but we claim the form of the piece of leather or other material, as described, by which we are enabled to make what is termed the "upper leather" of a boot, to fit any leg, foot, and heel, not absolutely deformed, of one piece, without crimping or joining other pieces thereto; the distinguishing characteristics of this form being that one-half or side of the boot is formed by a part A, without joint, and the other half or side by the junction of a part B, folded from the back of the side A, and part Ch, which is partly cut from, or which, when flat, lays close or near to the front of A above the instep, and partly folded over from the instep; the part Ch being of such shape as to form one side of the foot, and extend round the heel to the other side A, and cover an opening made in the lower part of the back, to give the required form to the heel, and also to make part or all of the necessary stiffening.

Pierre Demeure & Auguste Mauritz, of New-York City, for Bed Bottoms.

Claim.—The manner of constructing the spring mattress, by combining the vertical springs with an elastic or spring net-work of spiral metallic springs for supporting said vertical springs, or for increasing the elasticity, so that a person lying upon the bed will be equally supported on all sides, as described.

William P. Greenleaf, of Washington, N. H., for Shape of Scythes.

Claim.—Widening and curving the blade of the scythe at the shank, in the manner described, for the purpose of strengthening the same, and adapting it to cutting bushes as well as grass.

Z. H. Mann, of Cincinnati, Ohio, for Safety Valves for Steam Boilers.

Claim.—The construction and application to a safety valve of flutter wheel, governor, and supplementary lever, as described, or equivalent devices, in order to insure promptness of action and an increase of vent, according to the force of steam; and this I claim either with or without the adjustable link and counter weight, as described.

George Potts, of Cincinnatti, Ohio, for Revolving Mandrel for Lining Cylinders with Metal.

Claim.—The revolving mandrel, furnished with one or more rollers, whose distance from the axis of the mandrel can be increased or diminished by means of a nut, sleeve, and conical head, as described, or any equivalent device, for the purpose of lining with one metal the interior of a cylinder formed of another metal.

Andrew Robeson, Jr., of Newport, R. I., for Bucking Cloth. Patented in England Nov. 8, 1852.

Claim.—The employment of a closed kier or vessel, as described, and extracting the bowking liquor from the lower part of it, and forcing it into the upper part of it, while steam is being injected only into the upper part of the said vessel, and on the top of the goods, whereby, while the bowking liquor is being thrown on the top of the mass of goods, the steam is constantly and simultaneously made to press upon and pass into and through the goods, and facilitate the action of the bowking liquor, and its passage through the cloth, as stated.

Hervey S. Ross, of Cincinnati, Ohio, for Fences.

Claim.—The zig-zag and interlocked arrangement of panel, supported by a swivel-joint to posts at suitable intervals, and having the joint between the two middle panels furnished with inclined hook and eye, each of said middle panels being provided with boards sloping in opposite directions, so that by the action of a flood, each half of the intervening line of panels may separate midway and swing in the direction of the current, or devices substantially equivalent.

By Samuel B. Sumner, of Grantville, Mass., for Boot Jacks.

Claim.—The application to an instrument for taking off boots of the side bars B, the shaft and the bar D, arranged and operating in the manner described.

Josiah M. Smith, of New-York City, for Cutter Head for Moulding Machines.

Claim.—The combination of the slotted supporting flanges, or their equivalents, with the chisels hinged and operated as set forth.

Richard H. Townsend, of New-York City, for Working the Valves of Steam Engines.

Claim.—First, the combination of a cam and eccentric, by means of the sector, or its equivalent, to operate on the valve or parts that move the same, and cut off or work with the full pressure by the eccentric, according to the position of said sector, as described.

Second, I claim adjusting the position of the sector, by means of the governor through the screw, or other suitable means, whereby the governor regulates the position of the sector to communicate the desired motion to the valve of the engine from the eccentric or cam, or both, according to the power required from the engine, as specified.

Third, I claim the rod and points to take motion from the block, at its extremes of motion, and communicate the same by means of the right angle lever to the throttle or stop valves, as specified.

Frederick W. Norton, of Lasswade, Great Britain, for Manufacture of Plain and Figured Fabrics.

I do not confine or restrict myself to the precise details or arrangement which I have had occasion to describe or refer to, as many variations may be made therefrom, without deviating from the principles or main features of my invention.

Claim.—First, the manufacture of woven fabrics by cross-weaving, by carrying the cross-warp alternately over a stationary warp, and binding the cross-warp on each side of the stationary warp by a shot of filling.

Second, carrying contiguous movable cross warps over and across each other's path, and over one or more stationary warps, and binding said cross-warps to the stationary warps, by shots of filling.

Third, the manufacture of ornamental fabrics by cross-weaving elongated printed warps, as described.

James Rankin, of Detroit, Mich., for Hanging Mill Saws.

Claim.—The arrangement of an air-chamber, cylinder, and valve, as described, for the purpose of straining saws in motion by the elastic pressure of compressed air, or its equivalent.

John Chilcott & Robert Snell, of Brooklyn, N. Y., for Screw Fastenings for Boots and Shoes.

Claim.—The combination, as described, of two screws, of which one forms a nut for the other, and will hold it secure until it is all worn away.

L. A. Stockwell, of Batavia, N. Y., for Lard Lamps.

Claim.—The combination of a reservoir of a lamp for burning lard or tallow, with an outer covering so arranged as to form an air-chamber surrounding the reservoir, in the manner described.

T. J. Alexander, of Westerville, Ohio, for Sawing sticks for Broom Handles.

Claim.—The method described, of handling and adjusting the log to its place, and to its various positions for the several cuts, by means of the radius rods or clamping screws, coupled and operated as specified, and suspended by a swinging frame from above, arranged and operating together, as set forth; so that by bearing laterally on the screw lever or handle, whilst turning it, the clamping screws are swung laterally and raised or lowered simultaneously to approach the log off the table, and convey it with facility to the gauge, and to adjust the log expeditiously, when under operation, to its various sets, laterally and vertically, as described.

James Black, of Philadelphia, Pa., for Planetary Hydraulic Steam-Engine.

Claim.—The planetary hydraulic steam-engine, the arrangement of the vessels, pipes, and diaphragms, or their equivalents, upon a shaft, so as to revolve with or upon said shaft, as set forth.

Uriah B. Boyden, of Boston, Mass. (No. 1), for Turbines.

Claim.—First, the leaning and inclining of the leading curves or guides to the plane of the wheel, as described.

Second, the making of the inside of the garniture, or the part of the gate next the disc, or both, of such a curvature or form, that the water at the upper part of the stream or streams, where it leaves the garniture or gate, will have a downward motion, or a direction inclining to the plane of the water-wheel, descending or inclining to the plane of the wheel from the commencement of the passages next the gate to about half way from the inner to the outer edge of the upper rim of the wheel, where they are nearly or quite horizontal, or nearly or quite parallel with the plane of the wheel; the inclination of that part of the lower surface of the upper rim of the wheel which is next the gate being the same, or nearly the same, as that of the lower surface of the gate next said upper rim, and the change from inclining to horizontal being gradual, as by a curve, or making the upper surface of the disc, next the lower rim of the wheel, to incline up towards this rim, and making the lower sides of the parts of the passages through the wheel, which are next the disc, ascending or inclining to the plane of the wheel, so that the stream or streams will gradually diminish in height, at the entrance or entrances into the wheel, so that the water which passes in the upper parts of the stream or streams will converge toward that which passes in the lower parts of the stream or streams, before striking the floats, and continuing this converging into the wheel to about one-half the distance from the inner to the outer edges of the rims of the wheels.

Thirdly, forming of the lower part of the tube which sustains the disc, and the forming the top of the disc, on that part of it next the tube, and fastening these parts together, as described.

I have, in sundry parts of this description and claim, for brevity, written of the turbine as having its common position, in which case the water descends, to pass between the leading curves without alluding to its ever having any other position, but I do not limit either division of my claim to the case, when it has the common position, but I extend my claim to the cases in which the wheel is vertical, or inclined to the horizon, and to the case, when the water ascends to pass between the leading curves, nor do I limit either division of my claim exactly to the forms above described, but I extend my claim to all forms which are essentially the same.

Uriah A. Boyden, of Boston, Mass. (No. 2), for Turbines.

Claim.—Firstly, the arrangement of a gate at the entrance of the water into the wheel, with a part or all of the garniture or lining, and other parts of the turbine within, over, and about the gate, such that the gate and a part of the garniture, if any be attached to it, may move freely, while the part of the garniture not attached to the gate, and other parts over and about the gate remain stationary, and so closely fitted, that little or none of the water in the flume can run to the upper part of the gate, excepting by passing under the stationary garniture, and afterward upward, so as to diminish the liability of sediment, dirt, or other substances, being carried by the water to the upper part of the gate, or movable part of the garniture, if any be attached to the gate, so as to obstruct the motion of the gate, or movable part of the garniture, essentially as above described.

Secondly, the leaning or the inclining of the floats, or buckets, of turbines to the rims of the wheels, so that when the wheel of a turbine is working, with the gate next the wheel partially open, the parts of the floats opposite the aperture formed by such partial opening of the gate, will be forward of those parts next the other rim of the wheel, so that the leaning of the floats will diminish the spreading or deflecting of the streams into the part of the wheel opposite to the gate, essentially as above described; though I do not limit my claim to any degree of, but extend it to any inclination which will substantially answer the same purpose, as this effect of inclining the floats depends upon the streams only partially filling the wheel, I do not extend my claim to inclining the floats to any such turbine or hydraulic motor as has no gate at or near the water-wheel, or other means of varying the width, thickness or number of streams which enter the wheel.

Thirdly, the arrangement of the diaphragms or partitions in reacting wheels, and in the wheels of turbines of different distances from the rims of the wheels, in the spaces between the floats, to facilitate the regulating the motions of the wheels essentially as above described; though I do not limit my claim to any particular arrangement as to the distance of these diaphragms from the rims of the wheels, but extend it to all arrangements which operate substantially as above described. But as the effect of these diaphragms depends on the streams only partially filling the wheels, I do not extend my claim to the arrangement of the diaphragms to such motors as have no gate next or near the water-wheels, or other means of varying the width, thickness, or number of streams which enter the wheel.

Fourthly, the combination of the device of making the gate at the entrance of the water into the wheel, to move separately from the garniture with leaning the guides or leading curves, which direct the water into the wheel, so that when the gate is partially open, the part of the water which passes by or near the surface of the gate, in flowing toward this passage into the wheel, made by such partial opening of the gate, has its motion directed the way the wheel turns, in consequence of the leaning of the said guides. I do not confine my claim exactly to any degree of leaning, but extend it to all degrees of leaning, which will essentially answer the same purpose.

I do not limit either of these four branches of my claim to such turbines or hydraulic motors as discharge the water at their peripheries, but I extend them to such as have the water enter their wheels at their peripheries.

Uriah A. Boyden, of Boston, Mass., for Hydraulic Motors.

Claim.—First, the arrangement of the gates around and next outside of the peripheries of the water-wheels, between the wheels and the guides, or other things which cause the water to move obliquely toward the wheels, in the way the wheels turn, when the water first strikes the floats or buckets, as described.

Second, the device to cause the height of the wheel, or the position of the parts which partially confine the water which presses the wheel upward, to vary, as the height of the water or fall varies, so that the width of the aperture, which lets the water escape from the place where it presses the wheel upward, varies proportionally to the quantities of water pressed into it, so that the force with which the water presses the wheel upward will be nearly or quite constant, though the height of the fall varies greatly.

Third, the combination of a gate around and near the periphery of a water wheel, between the wheel and the guides, or other things which direct the water the way the wheel turns into the wheel, with the parts of the floats near the gate, curved so that the water will strike their concave sides, as described, though I do not limit my claim exactly to any curvature of the floats, but extend it to all curvatures, which will essentially answer the same purposes; nor do I limit my claim to an annular gate between the wheel and the things which cause the water to move the way the wheel turns, before it enters the wheel, but I extend it to all things which will substantially answer the purpose of a gate, in varying the height, thickness, width, or number of streams that enter the wheel.

Fourthly, the shape of the spaces between the rim of the water-wheels, which the floats are fastened to, in which they flare toward the axis of the wheel, as above described; though I do not limit my claim to exactly the flaring described, but extend it to all flaring, which will essentially answer the same purpose.

The first, third, and fourth branches of my claim apply only to such hydraulic motors as have guides, or other things which cause the water to move obliquely toward the wheels, in the way in which the wheels turn, and pass into the wheels at their circumferential parts, and, after acting on the floats, discharge from the floats inward. I do not extend these divisions of my claim to the class of tub-wheels and under-shot wheels, in which the water generally flows into the wheels in streams, with spaces between the streams, at which spaces the water does not flow into the wheels.

Though I have described these water-wheels as being horizontal, and the gates as being opened by raising, it is obvious that all these four branches of my claim are quite applicable to wheels in other positions, and to cases in which the gate is opened by lowering, and I do not limit either branch of my claim to cases in which the wheels are horizontal, or to cases in which the gates are opened by raising.

Alfred F. Chatman, New-York City, for Razor Strops.

Claim.—The metallic renovator, in combination with the spring barrel, or its equivalent, to operate on the strop, as specified.

I also claim the convex end and rest to elevate the centre of the strop, as described and shown.

Isaac Fay, of Cambridge, Mass., for Railroad Car Seats.

Claim.—The combination of the groove, and one or more dogs as applied thereto, and made to operate for the support of the back, and to enable it to be elevated, or its supporting pin raised out of the groove *a*, as described.

And in connection with the inclined notches and long slot of each bar, I claim the sliding-bolt or slide, as applied thereto, and used substantially in manner and for the purpose as specified.

And I claim the convex and concaved toothed racks, in combination with the seat and the chair frame, the same being for the purpose of enabling the seat to be set with such inclination, either forwards or backwards, as may be conducive to the ease and comfort of the sitter, whether he be in an upright or recumbent position.

David Freed, of Huntingdon, Pa., for Toilet Furniture.

Claim.—The attaching or combining with a wash-stand, or any other toilet or chamber furniture, the brackets and bolt, when said bolt is thrown against the brackets, by means of a crank or knob at or near the top of the stand, through the levers, or their equivalents, in the manner and for the purposes set forth.

Samuel Helbert, of Ogdensburgh, N. Y., for Ploughs. Patented in Canada, Sept. 29, 1852.

Claim.—Constructing a mould-board of a plough so that a horizontal line drawn at any height across its working side shall describe the convex arc of a given circle, and any line drawn across its working side at right angles to the base, shall also describe the convex arc of a circle, substantially, as set forth.

Samuel Jenkins, of Portsmouth, Pa., for Seed Planters.

Claim.—The peculiar shape and construction of the adjustable cutter, its passing through the drag-bar, and fitting in a dovetail in the point of the shovel, all in combination as described, for the purpose of allowing the tooth to pass easily over any obstructions, and especially to regulate the depth of the furrow.

Oliver S. Leavitt, of Marcellus, N. Y., for Hemp Breaker.

I do not claim as my invention the beating of flax or hemp straw into grooves, for the purpose of divesting it of the shives, or the woody portion thereof, or the use of rollers for moving the material to be broken, as that has been done before.

Claim.—The combination of a reciprocating beater, with parallel blades, set at decreasing distances from each other, with a fixed bar fluted or serrated, to correspond with the blades and spaces of the beater.

Oliver S. Leavitt, of Marcellus, N. Y., for Drawing Frames for Hemp and Flax.

I make no pretension to the use of gill bars attached to chains or wheels, in drawing flax, hemp, and other fibrous substances, as this has been often done before.

Claim.—First, the particular form of gill bar described, in combination with the rocking lever, the dog and cam, or tappet, for the purpose of withdrawing the gill-pins from the material, and directing the bars' backward movement, as set forth.

Second, the device by which the rods are pressed down, for the purpose of making the gill-pins penetrate effectually the material to be drawn, being operated by the lever in the manner set forth.

Warren Lyon, of New-York City, for Metal Drills.

I do not claim the weight attached to the arbor, irrespective of the levers and counterpoise, nor do I claim any of the within-named parts separately.

Claim.—The combination of the weights, levers, and counterpoise constructed, arranged, and operating in the manner and for the purpose as substantially shown and described.

James R. Nichols, of Haverhill, Mass., for Fluid Cans.

Claim.—I do not claim as my invention the helical spring and cork valve, as applied to other purposes than that of a decanting vessel or lamp-feeder; but I claim the improvement upon the decanting vessel, in the application to the same of a spring or valves, easily and conveniently opened by the thumb or finger, while replenishing lamps, or decanting therefrom, whether said spring and valves be made and arranged in the manner as described, or other mode substantially the same, by which similar results shall be produced.

Henry Perrin & William Rudduck, of Wilmington, Ohio., for Seed Planters.

Claim.—The method of supplying the distributing tube with grain or seed from the hopper, by means of the reciprocating vibratory valve in the hopper, in combination with the cap and the discharging plate, and receiving chamber, as described.

Philo Sylla & Augustus Adams, of Elgin, Ill., for Grain and Grass Harvester.

Claim.—First, the weighted levers, or their equivalents, substantially as described, which carry the sickle-bar and sickle, and allow them to vibrate perpendicularly, and accommodate the sickle to uneven ground, in cutting grass, which levers may be made permanent, when cutting grain, as described.

Second, the linked or hinged brace, or its equivalent, in combination with the levers, which brace prevents the sickle-bar from being traversed longitudinally by the action of the sickle, but allows it to vibrate perpendicularly, and accommodate itself to uneven ground, as described.

Third, the stands of the binders constructed so as to allow them to stand so much lower than the horizontal platform, that they can bind the gavels into sheaves with greater facility, far less labor, and much faster than by any of the modes heretofore practised.

Ancil Stickney, of Norwich, Vt., for Blow-Pipes for Enlarging Blasting Cavities. Antedated May 10, 1853.

I do not claim the enlarging a drill hole by the use of heat, or a blast of air thrown upon charcoal or other fuel in a state of combustion.

Claim.—The process of enlarging the drill hole by means of an air blast, and charcoal or other combustible fuel placed in the hole—the same consisting in the employment of a blast tube, made with lateral perforations, and a closed or nearly closed bottom, as described; the same enabling me to attain the enlargement of a hole with a great saving of labor and time, as set forth.

Ancil Stickney, of Norwich, Vt., for Compound Blow-Pipe for Enlarging Blasting Cavities. Antedated June 11, 1853

Claim.—I lay no claim to the use of a blast of air or gas in connection with coal or fuel, for the purpose of supplying such with oxygen; but I claim an instrument for enlarging the drill hole by the employment of gases as specified, meaning to claim the combination of the two jet chambers, the perforations or orifices and supply tubes, for commingling the gases and disseminating flame therefrom, entirely around and against the side of the drill hole, whereby the enlargement of it into a suitable charge chamber may be speedily effected.

Abel Shawk, of Cincinnati, Ohio, for Steam Generators.

Claim.—A tubular generator which has a forced circulation, and which, while it lines the fire-box, and is expanded in its diameter from above the fire box, to its termination, is connected to a steam chamber or receiver, outside of or exterior to it, arranged in the manner described.

O. Willis, of M'Dowell Co., N. C., for Saw for Water-Wheels.

Claim.—An adjustable apparatus for sawing out the grooves or fillets in water-wheels, for the reception of the buckets, composed of a two-edged saw sprung between clamps, and connected by a screw rod to a sliding bar; when said sliding bar is made adjustable upon a radius arm hung to the centre of the wheel, the whole being combined and operating as described.

George Gorman, of Lamar, Mass., for Cotton Stalk Cutters, or Pulverizers.

Claim.—The construction and arrangement of a machine consisting of rotary whippers, or reels, on bars supported in a frame admitting of elevation and depression; said whippers being driven by band wheels, on one or both supporting wheels of said machine, in the manner set forth, for the purpose of effectually reducing the stalks of cotton, and thus rendering them useful as a manure, and in a condition to offer no obstruction to the plough in the after cultivation of the land.

Halvor Halverson, of Hartford, Conn., for Looms for Weaving Hair Cloth.

Claim.—The combination of the trough or troughs, one or two depressers, one or two sets of pincers applied to the shuttle and mechanism, for opening and closing the pincers, the whole being applied to one or both ends of the lay, and to the shuttle, and made to operate together, for the purpose of carrying hair or hairs, or like matters, into the shed of warps, as specified.

And I also claim the arrangement of each or both troughs, with respect to the depresser or depressers thereof, and to the shuttle boxes and the lay, the trough in such arrangement being made to extend from the depresser toward the middle of the lay, substantially as specified.

Henry Hochstrasser, of Philadelphia, Pa., for Sash Fastener.

Claim.—The self-acting catch, made and operating substantially as described.

Nicholas Mason, of Rockshury, Mass., for Cooking Ranges.

I am aware that hot air chambers have been applied to ranges, for the purpose of heating meats, dishes, &c.; and also that hot water spaces have been applied to the sides of the grates instead of at the back. I, therefore, lay no claim to such devices.

Claim.—The employment of two ovens, in combination with the peculiar arrangement of the flues around their top, bottom, back, and sides, by which I am enabled to heat five sides of either one or both of them at a time, as set forth.

Henry McCarty, of Pittsburgh, Pa., for Manufacture of Sheet Iron.

Claim.—I do not claim the use of rollers generally, but I claim imparting to the surface of sheet iron, the peculiar mottled appearance of Russia sheet iron, by passing the sheet between a pair of planished or hammer-dressed rollers, in the manner as set forth.

Jordan L. Mott, of New-York City, for Cooking Stoves.

I do not claim as my invention any particular mode of securing the top plate of the bottom flue to the series of flue tubes: this may be done in various ways.

Claim.—Connecting the top plate of the bottom flue with the lower part of the series of flue tubes, so that in taking out the series of flue tubes for cleaning the said top plate of the flue below, it shall be removed at the same time, and thereby expose to view the lower flue space, greatly facilitating the operation of cleaning.

Second, I do not claim hanging the grate irrespective of the combination, as my invention.

What I claim is the combination of a swinging grate, as described, with the self-acting weighted latch, connected with the plate below the grate, as specified, whereby the contents of the grate can be readily discharged, and the grate readjusted by the slight use of a poker.

Jordan L. Mott, of New-York City, for Bathing Tubs.

I do not limit myself to any particular form for the projection *e*, or to its locality, nor to the forms of the channels therein, as these may be varied at pleasure, although I prefer to make the whole, as described.

Nor do I wish to limit myself to the making of the two channels in one and the same projection, as they may be made each in a separate projection, and located at different parts of the tub.

Nor, finally, do I wish to limit myself to the use of the channels, in combination, as the use of either one of them will greatly improve the bathing tub.

I do not claim broadly as of my invention the connection of the hot and cold water pipes of a bath tub, so as to discharge hot and cold water together, as this has before been done by a pipe or pipes, coupled with the bottom of the tub, and discharging upwards.

Nor do I claim broadly the use of an overflow pipe, for carrying off the water, and preventing the water in the tub from overflowing, as a separate device has before been used for this purpose; but when so used, it was so connected with the waste and supply pipes, as to necessitate the use of a valve within the waste pipe, with all its attendant disadvantages.

Claim.—The before-described mode of combining with a bathing tub, either one or both of the channel-ways, substantially as described, and making, when constructed, part of the tub, one of which channel-ways connects the overflow, and the waste or discharge holes with the waste pipe, and the other channel-way is adapted to the insertion of the hot and cold water pipes, and discharging the hot and cold water together at or near the bottom of the tub, and in a horizontal, or nearly horizontal position, substantially in the manner specified.

Christian Sleppy, of Newport, Pa., for making Chains.

Claim.—The forging and making chains out of a solid bar, without the welding process; and which is done instantly, as the bar passes between four rollers, with dies on the edges of the same, moulding the links into form, and which may be done out of iron, brass, or any substance suitable to be used as a chain, from the size of a cable to a watch-guard.

David Stuart, of Philadelphia, Pa., for Annealing Hollow Iron Ware.

Claim.—The process substantially as described: the same consisting in coating the articles in the manner set forth, with the same composition that will resist heat and exclude air from the surface, and heating the articles so coated in an oven about the length of time specified.

Robert Waskey, of Mill Creek, Va., for Smut Machines.

Claim.—The construction of the diaphragm, the central part being solid, and that near the periphery made in several oblique passages to check and throw back the kernels of grain, as represented.

William Zimmerman, of Quincy, Ill., for Smut Machines.

Claim.—The machine described, for cleaning and scouring grain, hulling rice, pearling barley, hulling buckwheat, or otherwise operating upon grain, seed, &c., with a series of two or more stationary cones, with one, two, or three, or more revolving cones placed and operated alternately between the stationary cones; the insides or outsides of part, or both sides of part, or all the cones being furnished with roughened surfaces, of such a form or kind, as will perform the service required, substantially as described.

Charles E. John & Samuel Wetherd, of Baltimore, Md., for Steam for Actuating Engines. Patented in England May 25th, 1853.

Claim.—The combining steam or superheated or surcharged steam for actuating engines, when generated, the elasticity increased and operated as set forth.

William Brown, of Glasgow, Scotland, for Preparing Paraffine Oil.

Claim.—First, the use of superheated steam, as indicated, for the purpose indicated.

Second, I claim the mode of separating and purifying eupione lubricating oil and paraffine, obtained by previous process.

Caleb B. Burnap (assignor to Lucius F. Robinson), of Hartford, Conn., for Method of Veneering.

Claim.—The method of pressing veneers on to the surface to which they are to be glued or cemented, by means of a fluid hot or cold, acting on an interposed flexible substance, such as an India rubber cloth, or its equivalent, which will adapt itself to the surface, substantially as described.

Daniel P. Fales, of West Poultney, Vt., for Car Wheels.

I am aware that car wheels, composed of two side plates of different shape, cast in one piece with the hub and rim, in which the rear plate is made to combine the inner end of the hub with the face plate, and with alternate portions of the inner edge of the rim, have been made by Bristol and Jackson, and, therefore, I do not claim to be the inventor of this description of car wheels.

Claim.—By my improved car wheel, composed of the face plate F, which curves first inwards and then outwards, and expands into the rim, and the rear plate B, which, by the series of curves, combines the inner end of the hub with the face plate, and with alternate portions of the inner edge of the rim, substantially as set forth.

James M. Dick, of Buffalo, N. Y., for Railroad Switches.

I do not claim the levers, springs, bolts or connecting rods. Neither do I claim of itself the employment of a sliding bar connected to the switch.

Claim.—The construction of the slide with the depending flanges or side plates, which inclose the slide and crosspiece upon which it works, and afford a certain and effective protection against gravel, dirt, snow, sleet, ice, and other foreign substances, which might otherwise enter between them, and derange the operation of the switch.

Charles H. Platt, of New-York City, for Ships' Blocks.

I do not claim the plates F G, for the purpose of securing the cheeks the proper distance apart, for they have been previously used.

Claim.—The employment or use of the rods E, passing through the cheeks in a direction transversely of their fibre, for the purpose of preventing the splitting of the cheeks; said rods also securing the plates F G to the cheeks, and forming a staple for the hook as described.

I also claim the rods placed underneath the ends of the shaft, for the purpose of preventing the wearing of the cheeks, and thereby forming durable bearings for the shaft, as set forth.

William Richardson, of New Orleans, La., for Centrifugal Draining Machines.

Claim.—The arrangement in the tub Y of the induction tube A, supply bulb B, and annular tube or ring D D, placed below the water line exterior of the tub, in combination with the ascending tubes E E and F F, and a second annular tube G, having discharges H H, for the purpose of self-priming, protecting the machine from the resistance of water exterior thereto, and giving steadiness to the ascending column of water discharged by the machine.

Stephen E. Parrish, of New-York City, for Clamp for Laying Floors.

Claim.—The use of the brace, having clawed ends for acting at opposite sides of a beam, in combination with a screw working at right angles to the same, substantially in principle of construction and operation, as set forth.

RE-ISSUES.

William Crompton, of Hartford, Conn. (assignor to Merrill H. Furbush & George Crompton, of Worcester, Mass.), for Fancy Power Looms. First patented Nov. 25, 1837; extended April 9, 1851; re-issued Sept. 13, 1853.

Claim.—First, the jacks with hooks or projections thereon, capable of being taken or passed by the lifter and depresser, as required, in combination with the harness or heddles, for the purpose of opening the shed.

Second, the combination of the jacks, constructed and arranged as described, with the lifter and depresser.

Third, The combination of the pattern chain or cylinder with the jacks constructed as described.

Fourth, arranging and connecting the lifter and depresser, which operate the jacks in such a manner, that they shall operate simultaneously to elevate and depress the jacks and warps in forming the shed, as described.

Fifth, giving motion to the pattern chain or cylinder, as described.

Sixth, the combination of the pattern chain or cylinder with the jacks, lifter, and depresser, as described.

Seventh, so constructing or arranging the lifter and depresser, and the hooks or projections on the jacks, with reference to each other, as set forth, as to bring the upper warps all into the same plane, and the lower warp all into another, when the shed is opened.

I do not claim broadly the bringing of the warps into said planes.

Eighth, connecting the hook jacks to the bottom treadles or levers, by inclined wires, or their equivalents, to hold the jacks against the tubes or bars of the pattern cylinder or chain, when not thrown out by the rollers, or other projections thereon.

ADDITIONAL IMPROVEMENT.

George F. S. Zimmerman, of Charlestown, Va., for Winnowers and Threshers. First patented Feb. 8, 1853.

Claim.—Constructing the suction pipe or tube, of any desired form, with a sliding hinged flap bottom, attaching said tube to the side of the thresher or winnower in any position, and also attaching said pipe or tube to the grain discharge or bagging spout, having a sieve-like or reticulated bottom, and using said attachments in combination, for the purpose of cleaning and chaffing, or double winnowing grain of all kinds, with a blowing blast of air, and a suction draught or current of wind, also in combination, and in one operation, and at the same time, as set forth.

I do not, however, claim inventing or originating the double cleaning of grain, but simply the peculiar combination mentioned.

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For Appletons' Mechanics' Magazine.

Mechanics for Practical Men.—Strength of Iron.

No. 4.

The expression $\frac{l^3 P}{b d^3}$ given on page 238, as representing the deflection of a rectangular beam under a weight represented by P. This may be otherwise expressed, as follows: The deflection of a beam under any load varies directly as the load, multiplied into the cube of its length, and inversely as the breadth into the cube of the depth.

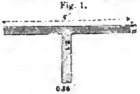
The effect of temperature on the transverse strength of cast iron is found to decrease it up to 190° Fahr., from that to 600°, the strength increases. At 26° and 190°, the strength is 874 : 743 for the cold blast, and as 811 : 781 for the hot blast.

Of the best form for cast iron beams to resist a transverse strain.—This is a subject of the first importance to the engineer and architect. The proper proportioning of beams and girders, placing the metal so as to best resist the strains to which it will be subjected, and throwing away all useless metal, as only adding to the weight, and not increasing the strength, is very evidently a great desideratum. As the action of the transverse strain is rather complicated, it could not be expected that experience alone would determine the best forms to be adopted, without proper investigations. Theory has already assigned the best forms, and all the experiments that have been made, including the late and very valuable ones of Mr. Hodgkinson, have proved the results obtained by theory. The universal thanks of engineers are due to this gentleman for the great skill and care with which he conducted his experiments, leading to such valuable results, and, above all, for his zeal, without which no investigations can be of value, or be depended upon.

The following table is from his experiments on bars of a uniform cross section (thus T) of cold-blast iron.

The bars were rested on supports 4½ feet apart.

Fig. 1.



The annexed figure gives the cross section and dimensions of the bar. In pieces of this section the upper broad part is usually called the web, marked A in the figure, and the lower part B, is called the rib.

In experiment No. 1, the bar was placed with the web uppermost; in No. 2, with the web down.

Experiment 1.			Experiment 2.		
Weight in pounds.	Deflect'n in inches.	Set in inches.	Weight in pounds.	Deflect'n in inches.	Set in inches.
112	·03	–	112	·03	–
224	·07	–	224	·07	–
336	·11	–	336	·11	–
392	·13	·005	448	·15	–
420	·14	·007	560	·19	·005
448	·15	·010	616	·21	·010
560	·19	·012	672	·23	–
672	·23	·015	728	·25	·015
784	·28	·023	784	·27	–
896	·33	·30	896	·31	–
952	·35	–	1008	·35	–
980	broke	–	1120	·39	–
–	–	–	1344	·48	–
–	–	–	1568	·57	–
–	–	–	1792	·67	–
–	–	–	2016	·80	–
–	–	–	2240	·95	–
–	–	–	2296	–	–
–	–	–	2352	broke	–
Ultimate deflection 0·36.			Ultimate deflection 1·03.		

From the form of the bar used in this experiment, it is evident that nearly the whole of the extension or compression due to the flexure would take place in the vertical rib, the web being so broad as to be comparatively inextensible and incompressible, and acting as a fulcrum. The results obtained with the web uppermost, compared with those in which the rib was uppermost, the rib being respectively extended and compressed, will show that the "set" or defect in elasticity is about the same, whether it arises from extension or compression.

Mr. Hodgkinson is induced to believe, from his experiments, that cast iron will take a permanent set, under very small strains, even as low as 1-50th the breaking weight, the set, of course, being very minute; but there are practical limits, determined by experience, which may be safely approached in practice, and which will be given further on under the head of Practical Formulæ. Mr. Hodgkinson's experiments have induced him to adopt the following form for cast iron beams, as best adapted to resist a transverse strain.

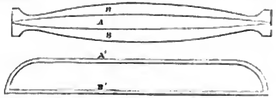
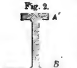


Fig. 2.



It will be seen from the figures, that the beam consists of a vertical rib, and an upper and lower web. The vertical rib has a uniform depth and thickness, the upper and lower web are of uniform thickness, but variable breadths, tapering from the centre towards the ends, and bounded by portions of parabolas, whose vertices are at the centre of the beam. The top flange or web is seen to be much smaller than the lower. The following are the relative dimensions of this beam:

Distance of supports,	4' 6"
Total depth of beam,	0' 5¼"
Breadth of upper web at centre of beam,	0' 2·33"
" Bottom " "	0' 6·66"
Thickness of upper web,	0' ·31"
" Bottom,	0' ·66"
Thickness of vertical rib,	0' ·27"
Total area of cross section,	6·4 sq. in.
Weight of beam,	71 lbs.

This beam broke in the middle with a weight of 25,084 lbs. The relative dimensions given above were arrived at by constantly casting the beam with a larger bottom flange until the resistance to compression could no longer be sustained. In all previous trials, the beam had yielded by the bottom flange, tearing asunder. This one gave way by a piece being forced out on the upper side. This form may, without doubt, be depended upon, as the best form to resist a transverse strain, and giving the greatest strength with the same amount of metal.

Mr. Hodgkinson gives the following rule for determining the ultimate strength of beams of the above form, with the weight applied at the middle:

Call the breaking weight, in tons, ...
Call the area of the cross section of the bottom flange taken at the middle of the beam, ... a
Call the depth of the beam at the middle, ... d
Call the distance between supports, ... l

Then $W = 26 \frac{a\,d}{l}$.

This supposes that the beam has been proportioned after the above model.

The following are some of the results of Mr. Hodgkinson's experiments, on hollow and solid columns of cast iron.

In solid columns, the ends being in a plane perpendicular to the axis, and the strain passing through the axis, the strength is proportional to 3·6 power of the diameter, the length being equal. When the diameters are the same, the strength is proportional to the 1·7 power of the length. That is, if we have two pillars of the same diameter, but whose lengths are represented by A and B, then their strengths are to each other as $A^{1·7} : B^{1·7}$. These remarks and those which are to follow are intended to apply to long pillars or columns, such as are used in building, &c., and whose cross section is a circle. It is seen from the above, that the strength or resistance to flexure of long pillars is as $\frac{d^{3·6}}{l^{1·7}}$ in which $d =$ the diameter and $l =$ the length.

A pillar, whose ends are rounded, has only ⅓d of the strength, when the ends are flat, in the usual form. The absolute strength of pillars with flat ends is found by the following formula:

$$\text{Strength in tons} = 44·16 \frac{d^{3·6}}{l^{1·7}}$$

And for hollow pillars, D and d being the external and internal diameters.

$$\text{Strength in tons} = 44·3 \frac{D^{3·6} - d^{3·6}}{l^{1·7}}$$

These formulas apply only to pillars whose lengths are not less than 30 times their diameter. It must be borne in mind that these rules give the absolute ultimate strength, not the practical limit.

The results of experiments on pillars of the same dimensions, but of different materials, give the following:

If we call cast iron 1,000, we have for wrought iron 1,745, for cast steel 2,518, for oak 109, and for deal 78. If pillars with flat ends are shorter than 30 times their diameter, or if they have rounded ends and are shorter than 15 times their diameter, they will be crushed as well as bent, and the value of the breaking weight will be modified thus, $W' = \frac{W c}{W + \frac{3}{4} c}$; in which W represents the breaking weight, as calculated by the preceding formulas, and W' the true breaking weight; c represents the weight necessary to crush the pillar, supposing it was prevented from bending.

It will be remembered the length of the pillars are taken in feet, and the diameters in inches.

The absolute strength of a pillar of wrought iron, with flat ends, and whose length exceeds 30 times its diameter, is expressed by the formula,

$$\text{Breaking weight in tons} = 133·75 \frac{d^{3·55}}{l^{2}}$$

The best form for strength for solid pillars of any material, is that of a parabolic spindle, the diameter at the ends being about ¾ that at the middle; but to obtain the greatest strength with the least amount of material, it should be made hollow, with the ends fixed, the strain passing directly through the axis of the pillar.

Strength of wrought iron.—This material has been the subject of a great many experiments, and the conclusions arrived at are as follows: That ordinary quality wrought iron in bars may be rated at 50,000 lbs. per square inch of cross section; that the best quality Swedish and Welsh may be placed at 60,000 lbs. per inch of section; and that American wrought iron ranges between 40,000 and 50,000 lbs. per inch of section.

As to the limit of elasticity of this material, Professor Barlow states, as the results of his experiments, that a bar one inch square of malleable iron, is elongated the 0·0001 part of its length, by a strain of one ton; that good iron is extended the 0·001 of its length by a strain of ten tons per square inch, and is injured by this strain; and that ordinary iron is injured by a strain of eight tons. According to the experiments made under the direction of the Franklin Institute, the extremes by which a permanent set may be given vary between the 0·416 and the 0·872 of the ultimate strength, the mean being 0·640. Placing American iron at 45,000 lbs. as the ultimate strength, the inferior limit agrees very well with Professor Barlow's results. The limit of elasticity is the element to be considered in fixing the amount of strain to which a body may be subjected safety in practice. The English place this amount for wrought iron, when used in the form of tie-rods, suspension bars, &c., or in any form in which it is subjected to a steady strain of extension, at 10,000 lbs. per square inch of cross section. This limit is sanctioned by the usage of the most celebrated modern engineers, and probably could not be improved upon.

As wrought iron is seldom used to withstand a strain of compression, this point need only be noticed. Rondelet states that it yields under 70,000 lbs. per square inch, and yields by bending, when the height of the specimen is more than six times the radius of the base. The resistance of wrought iron to a transverse strain is governed by the laws already given for cast iron, and the following table from Professor Barlow's report, will furnish the constants for flexure.

The subject of the experiment was a bar 36 inches long and 2 inches square, the supports being 33 inches apart.

Weight.	Deflection in inches.
1500	·03
2000	·04
3000	·06
4000	·08
5000	·10
6000	set.

[To be continued.]

A Chapter on Mechanism.—Belting.

No. 1.

Among the many subjects which present themselves as especially worthy of notice in a short series of practical chapters, of which this is designed as a commencement, none perhaps are more deserving than that of belting, and this for two reasons. First, that it is a subject which more immediately concerns a greater number than almost any other which might be suggested; and, second, because it is least understood. The practice of each individual varies with regard to this; and in theory the subject is one which, from its comparatively recent introduction, if not from any inherent difficulties attending its examination, has not yet received any tolerable share of attention from mathematicians and theorists. The noisy rattle of the iron gearing has to a great degree been superseded by the humming of the quiet and flexible band, and the march of modern improvement has rendered that an every-day fact, with regard to the tractive power of belts in moving machinery, which was, a few years past, considered absolutely impracticable. The subject has certainly received in the past but little attention from the number of mechanical books and periodicals; and while we cannot attempt in a brief magazine series to do it full justice, we will endeavor to glance at all its most important features.

A belt serves to communicate power from one shaft to another. In doing so, it may be made materially to modify it by changing the elements of which it is composed. Power is always a compound quantity, its factors being force and velocity. Either of these elements may, by mechanical devices, be increased at the expense of the other.

At the risk of being somewhat tedious to the better informed reader, we may introduce in this series many well-known general principles to avoid the possibility of being misunderstood.

The belt being presumed sufficiently tight to prevent slipping, it is evident that it will move with the same velocity as the circumference of the driving pulley. The same assumption applied to the action of the belt on the driven pulley shows the circumference of both pulleys to move with the same velocity. This fact being established, it is evident that the angular velocities, or speeds, of the two shafts, will depend on how their circumferences compare with each other, the one having the smallest circumference revolving with the greatest rapidity. Now, the diameters of circles bear the same proportion to each other as their circumferences, so that we arrive at the simple proposition that the speed, or number of revolutions of two shafts connected by a belt, are inversely proportioned to the diameters of the pulleys on which the belt runs. If the driving pulley is 30 inches in diameter, and the driven 5 inches, the driver making 100 revolutions per minute, we may make the proportion thus—

5 : 30 :: 100 : 600,

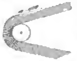
and 600 is the number of revolutions per minute performed by the driven shaft.

If the driver is 20 inches diameter, and makes 500 revolutions, the driven being 1 inch in diameter (this being about the proportion and speed often employed in cotton spinning), the revolutions of the spindle may be found in the same manner,

20 : 1 :: 5000 : 10,000 revolutions per minute.

This is the theoretical speed. In practice it is hardly possible to obtain as high a speed without some degree of slip to the belts; a consideration which impresses the fact, alike true in almost every department of mechanical practice, that theory cannot exactly coincide with practice. True theory, however, is only such, when all the known causes of discrepancy are carefully allowed for. The amount of loss from slipping of belts may be estimated at from 1 to 70 per cent. of the whole velocity, generally, except at very high speeds, approaching the limit first named. The discrepancy between the real and calculated speed may, in some cases, be readily detected by the ear with a little practice. None of the pseudo-scientific ideas inculcated by mechanical writers can be more easily disproved than that the ear can only detect 12 sounds per second. The ear has capacities in this respect far exceeding the organ of sight, and can probably recognize, as distinct and separate sounds, a series of sharp raps following each other, at intervals of less than 1-50th of a second. This slipping may be, in part, ascribed to the introduction of air between the pulleys and belt at high velocities, but at ordinary, moderate speeds, the slip may not be considered of appreciable value.

There is another consideration which may be here alluded to, although of still less practical importance. We allude to the effect which thickness of belt may exercise upon the relative speed of the two shafts. Leather belting is usually about ¼ of an inch in thickness, running upon pullies of such dimensions that this element cannot possibly affect the result more than 2 or 3 per cent. Let the accompanying figure represent the belt running upon a pulley. The belt will communicate to the periphery of the pulley only the velocity of that portion which comes into contact with it, and that that portion has a velocity less than the mean velocity, it is the object of this simple diagram to demonstrate. In bending around the surface of the pulley, the inside of the belt is compressed and the outside is extended. Each particle in the belt must necessarily have a velocity proportional to the distance from the centre, so that the outer side travels with a greater, and the inner with a less velocity than the mean. The comparative thickness of the belt is much exaggerated in the figure; but whatever the thickness, there may be assumed a line in which the particles suffer neither extension nor compression, and this line is the true theoretical position of the belt, the thickness between this line and the pulley being in effect so much addition to its magnitude. As this neutral line is probably very near the centre of its thickness, it follows, that to obtain the true ratio of velocities, the half of the thickness of the belt should be added to the radius of each pulley, or the whole thickness to the diameter, before making the computations. This fact, that the true radius of the pulleys is from its centre to the centre of the belt, may be of some value in estimating the effect of round cords running in sharp grooves.

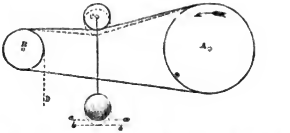


Belting is usually employed at speeds varying from 300 to 5000 feet per minute, and, with a few exceptions, as in the "feed" of lathes, and in impelling some printing presses, it is made to increase, rather than diminish, the number of revolutions. It is generally the case, however, that the motion is not transmitted from the prime mover to the work by one belt, but is several times multiplied by the interposition of counter shafts, or otherwise. By this the necessity is avoided, either for very large and cumbrous pulleys, or for bending a stout belt around a very small one. The effect of each pair of pulleys on the speed may be estimated separately, or the whole train may be taken together, thus:

Multiply together the diameters of all the driving pulleys measured in inches, and multiply the product by the number of revolutions of the first or prime mover per minute, and call this product the dividend; then multiply together the diameters of all the driven pulleys, and take the product for a divisor. Dividing the first quantity by that last found, the quotient is the number of revolutions per minute finally obtained. If great nicety is required, once the thickness of the belt should be added to the diameter of each pulley, before commencing the operation.

A certain degree of tension, varying with the width of the belt and size of pulley, and, to a considerable degree, with the tractive nature of the surface of the pulley, as well as the amount of resistance, is required to prevent slipping. This force or tightness may be equal throughout its parts, while the machinery is at rest, but when in active operation, it becomes far otherwise. It is evident that the only force tending to induce motion in the driven pulley is the difference in tension between the two parts of the belt. A portion of the belt extends from opposite sides of the pulley, in nearly parallel directions, and each portion tends by its pull to turn the pulley in opposite directions. If the driven shaft is performing any work, there must necessarily be a difference in the tension of the parts, and this, however rapidly the belt may be moving, so that every portion is alternately exposed to a greater and a lesser strain. It is also equally plain, that other things being equal, this difference in strain is directly proportioned to the amount of work or power which is transmitted. It matters little to our present purpose what the *absolute* strain may be. The difference of strain, estimated in lbs., between what we will term the tight and the slack side, multiplied by the velocity of the belt in feet per minute, will exactly indicate the amount of power conveyed per minute, measured in what some have termed units of power, or the same divided by 33,000 will give exactly the horse power so conveyed.

One of the simplest and most easily applicable methods of ascertaining this difference in strain in any case, and, consequently, of arriving at the exact amount of power conveyed by a belt in any situation, has been suggested to us by Mr. James Bogardus of this city, a gentleman long distinguished and appealed to as an authority in matters of this nature. The plan is so readily applicable, with but inconsiderable expense or trouble, that it may be generally adopted in the disputed cases which so frequently occur in the renting of power, &c.



Let A denote the driver and B the driven pulley, arranged to revolve in the direction denoted by the arrow. On the slack side of the belt adjust the tightener or tightening pulley C, loaded with any convenient weight. Now start the machinery, and when fairly and steadily in operation at its normal speed and load, note carefully the position assumed by the weight. It will be found to sink to the line *bb*, and there to oscillate vertically through a small space, the centre of which is to be assumed as the mean place of the weight. Stop the machinery, and the weight again rises to its original position. Knock the key out of one of the pulleys B (it is of no consequence which), secure the other so that it cannot turn, clamp on to the periphery of the pulley B a piece of old belt, and attach weights to it till the tightening pulley and its weight has descended to the same position it assumed when at work. The weights D will then be equal precisely to the difference in strain on the two parts of the belt, or, in other words, will represent exactly the weight which may be lifted vertically through a space equal to the velocity of the belt. If the belt moves 1500 feet per minute, and the weight P, required to produce an equal strain on it, be 300 lbs., the power conveyed by the belt from one shaft to the other, when the work is in operation, is equal to lifting 300 lbs. 1500 feet high in one minute. This is equal to [300 × 1500 =] 450,000 foot-pounds, or units of power; or, dividing by 33,000 $\left(\frac{450,000}{33,000} =\right)$ about 13½ horse power. This same method may, by a little ingenuity, be adapted to vertical belts, by letting the tightening cord run over a pulley, or by allowing the weight to act on the tightening pulley through the medium of a bent lever.

Correspondence.

[For Appletons' Mechanics' Magazine.]

On Warming and Ventilating Houses.

No. 4.

(Continued from page 215.)

Atmospheric air, when pure and fresh, contains aqueous particles to a greater or less extent, constituting its moisture or feeling of softness, in contradistinction to its dryness or feeling of harshness. These aqueous particles are water, which is found blended with atmospheric air to some extent, even in the dryest weather. Water is composed of oxygen and hydrogen, in proportion of one volume of the former to two of the latter. Iron, when heated, absorbs oxygen, but has but little affinity for hydrogen, which it liberates. Hydrogen is noticed for its extreme levity, one hundred cubic inches weighing but little over two grains; and hence its frequent and popular use for filling balloons. It is speedily fatal to animal life, when taken into the lungs. It combines with oxygen in the proportion of eight parts, by weight, of the latter to one of the former. If the air of a room, therefore, is made to pass into contact with red-hot metal, or through iron pipes running through or in close contact to the fire, its aqueous particles will be decomposed by the heat and elective affinity, the oxygen uniting with the iron, while the hydrogen is liberated, and may be collected in the form of gas.

The practice, therefore, of heating stoves and furnaces red-hot is productive of the most fatal consequences. It generates a gas of the most deleterious character, whose subtilty and levity causes it to permeate readily from the cellar to the attic. Its almost entire want of smell makes it an insidious and invisible enemy. And yet it is quite common to see heating apparatus of all kinds glowing red-hot. Fuel and draught are furnished in abundant quantities; sometimes by thoughtless and ignorant servants, but oftener by masters themselves, under a mistaken notion that it heats the air sooner, and that unless the iron is red-hot it is incapable of imparting caloric with sufficient speed, or to any considerable extent. They forget that the moisture of the atmosphere is perhaps decomposed thereby, and a gas let loose, most of all unfitted for respiratory purposes. What evils may we not attribute to this cause to the health of our houses and families!

Thinking to lessen the evil, vessels of water are placed upon stoves, in the vain hope that the artificial moisture thus communicated to the dry baked air will compensate for the natural freshness and vitality it has just lost. Hydrogen is not absorbed by water, except in very minute quantities, so that the presence of the new softness will not diminish, to any sensible extent, that fatal gas floating in the apartment. Vessels of water placed on stoves, however, are not entirely useless, inasmuch as the walls and wood work of the room, when dry, have a tendency to attract and absorb the moisture of the atmosphere; and to compensate for the loss thus occasioned (in addition to the loss above alluded to), the artificial moisture thus generated prevents a feeling of dryness or harshness that invariably accompanies heated air, as well as prevents, to some extent, the warping, shrinking, and cracking of furniture. However valuable vessels of water may be in this respect, the true evil lies deeper, and must be remedied by other means.

A reduction of the temperature of the heated metallic surfaces which are intended to warm the air must be made. All red-hot heats are to be carefully and sedulously avoided. This may involve an enlargement of the air-warming superficies, in order to make up for the reduction alluded to, by an increase of area, and consequent capacities for heating the air. The writer contemplates describing hereafter an apparatus which, in his opinion, fully meets this evil, affording, in a small amount of space, an enormous amount of heated metallic surface; so enormous, in fact, as to more than compensate for any sufficient and required reduction of temperature. The apparatus is intended to furnish immense and continuous volumes of sweet, fresh, warm air at low temperatures, unrobbed of its vitality, and fitted in every way for healthy respiration.

The hot water apparatus in common use proposes also to furnish a remedy for this crying evil. It claims to accomplish this end by confining its heating surfaces below a temperature of 212°, or that of boiling water. In some respects this apparatus is successful; but, as before remarked, its expense can only be borne by the wealthy. To make up for the lowness of temperature, the heating metallic area requires enlargement, and expensive lines of metallic vessels or tubes, having sufficient compensating heating superficies, must be used. The improvement referred to is also applicable to this kind of heaters, and its introduction in connection with them, will have a tendency to lessen the present expense of hot water apparatus, and render its use (if it has advantages) a thing possible to even the humblest citizen.

It is a mistake, however, to suppose that hot water apparatus generates a moist heat, though so often represented by the manufacturers. The falsity of this idea will be clearly apparent, when we reflect that the heating medium (water or steam) is concealed and shut up in metallic vessels, incapable of being permeated by the smallest particle of moisture. From their outer surfaces only is heat thrown out, or by contact with their outer surfaces is the atmosphere warmed. The reason why rooms warmed by this apparatus always feel moist and fresh, is because that as no decomposing or excessive heats are possible, the aqueous particles floating in the air remain untouched, and an undiminished feeling of moisture pervades the apartment. Many of the unhealthy effects of the presence of hydrogen are wanting, as well as the intense dryness so destructive to houses and furniture.

It is not impossible, we think, to construct hot air apparatus that will equal in every respect the best hot water apparatus in use; for we cannot but think, that if properly organized, the evils resulting from red-hot heats can be avoided or overcome. Such improved hot air apparatus will have the superior advantage of occupying much less space, and being comparatively inexpensive in its application. The common stove, intended simply to heat the apartment in which it is placed, can thus be rendered the origin of large volumes of pure, fresh, warm air, entirely undiminished in its moisture, and untainted by foul and unhealthy gases. For it is evident that it matters but little whether the apparatus be hot air or hot water, provided the heating surfaces do not exceed the temperature of boiling water, or do not reach the decomposing point of heat, which is fatal to the vitality of the atmosphere, or the presence of its aqueous particles. M.

(*To be continued.*)

To the Editor of Appletons' Mechanics' Magazine.

Effect of the Tides and Trade Winds on the Mechanism of the Heavens.

Believing the few attempts I have made in resolving knotty points to have been rather favorably received, I ask a brief space now to present a difficulty which I am unable to overcome. The question, although by no means one of immediate practical importance, seems to involve nothing but strictly mechanical science; and I know of no journal more likely to have among its readers those willing and competent to render a solution. The question is briefly this,—What *power* produces the tides of the ocean?

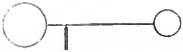
The *forces* impelling the tide wave in its various movements and counter-movements are the central forces arising from the mutual relations of the earth and moon, which I shall examine further on. *Power* is a force overcoming some resistance, and power is exerted in producing and maintaining the motion of the sea. There is a constant friction, how great I will not inquire, but tending constantly to diminish the agitation, and induce a state of perfect rest. To overcome this friction requires an expenditure of power; from whence is it obtained?

In all the operations of nature, as indeed of art, wherever power is exerted, it may be traced back to a source more or less remote. The sun shines on the sea, and it rises in vapor, falls on the hills, flows down in streams, and drives the mill. The sun shines on the air unequally, and currents are induced, which fill the sails of the ship, or creaking wind-mill. And, again, the sun shines on the seed, and induces it to vegetate and gather matter into organic forms of wood or coal, which, in their process of combustion or resolution again into their elements, give power to the steam or caloric engine. The dull oxide of a metal is, by the long application of heat, reduced to a bright pure form, capable of engendering in its return to a natural union with its favorite elements, a power more mighty, in proportion as the electro-magnetic engine is more perfect; and even in animal economy, we may be able to trace a relation between the air and food consumed in the lungs, and the power exerted by the muscles.

Water power, wind power, caloric power, electric power, and animal power, then, are traceable, directly or indirectly, to the action of the sun; and if there are other so called primary sources of power than the five here alluded to, it is presumed they may be referred back to the same great and more immediate agent of Almighty Power. Through which of these five sources, or to what other agency, common or uncommon, may the tide wave be traced?

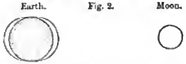
I have possibly presumed too much on a previous knowledge of the subject to suit all readers. I will very briefly explain. The earth revolves around the sun, and the moon around the earth. This is sufficiently correct for a district school recitation; but in point of fact, the earth and the moon revolve around a common centre of gravity between them, while this centre revolves around the sun. This is a distinction important for our purpose. Fix any two equal or unequal bodies on a light rod or wire, throw them freely into the air, with a whirling motion, and both will revolve around their common centre of gravity, while that centre will move in the path of an ordinary projectile. Neglecting, in this connection, to consider the various perturbations and inequalities, as also the motion of both around the sun, we find the earth and moon to be revolving around a central point, toward which each is drawn by the attraction of the other, and *from* which each is repelled by the centrifugal force arising from its circular motion. These forces of attraction and repulsion balance each other, and thus the stability of the arrangement is secured. Each moves in empty space, or nearly so, and as there is no appreciable resistance to be overcome, no power is expended.

Fig. 1.



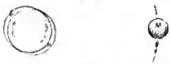
The sum of the centrifugal and centripetal forces felt by each particle of the earth's mass, when taken together, exactly balance each other; but it does not follow that the forces acting on *each particle* do so. In fact, it is evident, that if at the centre of the earth these forces are exactly balanced, a particle nearer the moon will be more strongly attracted and less repelled, while one on the opposite side will be less attracted, and being farther from the mutual centre, will be more strongly repelled by the centrifugal force. The consequence is a tendency to elongate the earth in that direction—a tendency much too slight to affect the solid crust, but which becomes apparent in the tidal elevations, which, if the whole surface were one continuous ocean, might be expected to assume a form as here represented, and to which, in spite of all obstructions, the ocean surface does sensibly approximate.

Fig. 2.



But the earth possessing a rapid revolution on its own axis, it follows that the water cannot permanently form any such equilibrium. The earth revolves, and by its friction, drags these elevations or waves partly around with it, bringing it into the form now correctly given, Fig. 3, in which we see the earth revolving on its axis, and the two great tide waves apparently rolling around it, but really maintaining very nearly the same position with regard to the moon; high water usually occurring on the open sea from two to four hours after the moon has passed the meridian, whether above or below the horizon.

Fig. 3.



It is to this true position of affairs, represented by Fig. 3, that I would invite the attention of mathematicians, astronomers, and *physicians* generally. The earth is revolving within a ring, so to speak, of water, which exercises a constantly-retarding force upon its motion. The case is analogous to the revolution of an eccentric within an ordinary eccentric ring, or to the revolution of any journal in a bearing. The circumstances differ only in this respect, that the water does not actually stand still, and let the earth revolve under it, but only accommodates itself to the motion of *a wave* in that direction. Yet this amounts to the same thing with an effect less only in degree, and the simple fact that friction is produced by the movement of the tides, proves indisputably that there must be power expended, and that power must have a source. If no other is suggested, it must be derived from the momentum or *vis-viva* of the earth. In short, the velocity of the particles of the earth, so far as the diurnal revolution is concerned, must be daily diminishing, in consequence of the friction of the tides, and *the days consequently be growing longer* by very small degrees!

On the nebular theory, that the earth was once a greatly extended mass of chaotic vapor, which has been, and still is, gradually contracting its volume, in consequence of cooling, the days should be growing *shorter* with each successive year or century; yet astronomical and chronological comparisons assure us that the length of the day has not changed, by the slightest appreciable quantity, since the earliest recorded observations.

Is it possible that I may have pointed out the counterbalancing influence, by carefully weighing which, the actual amount of contraction may be approximately ascertained, the question of the permanency of the universe, the existence of a resisting medium among the planets, &c., be forever and conclusively established?

The mass *a* being very nearly equal to the mass *b*, and considerably nearer the moon, the effect of its attraction is to increase the velocity of the moon in the orbit, and it is only necessary to suppose a corresponding tidal wave in any case in the primary to support the motion of the secondary planets, or possibly in the sun, to keep up the motion of the whole system, the annual or orbital motions being in each case supported at the expense of the diurnal motion of the body serving as a centre.

While this compensating element may thus be of immense importance, I am fully prepared to learn that it has no real existence. It may all be a creation of the imagination, or of imperfect information on my part; if so, will some one have the kindness to remove my fallacy? The trade winds, and to a considerable degree the hot and cold currents of the ocean, should also, on my theory, be a tax to some degree on the original *vis viva* of the earth; but to follow out its application in that direction, would too much increase this already too extended article. MACHINIST.

New-York, October, 1858.

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Chronometer Escapements.

Mr. S. M'LAUGHLIN, clock and watchmaker, at Quebec, informs us that he has invented an improvement on Mr. Denison's spring remontoir, to apply to a particular kind of chronometer, which he is constructing, intended to go without mainspring, chain, or fusee.

Referring to the description of Robjohn's escapement (August No. p. 190), he points out what he conceives to be a defect in Mr. Robjohn's arrangement. "The part of the improvement," he remarks, "which I claim having invented, is the locking-spring, stud, and lifting jewel."

"Mr. Denison's remontoir claims the fly to escape, that the spring which drives the escapement wheel may be bent up, and also stops it when sufficiently bent up. The defect in Mr. Robjohn's arrangement is, that when the lifting jewel raises the locking-spring, and frees the fly, there is nothing to stop it, when the remontoir spring is sufficiently bent up, consequently the fly will continue to revolve until the lifting jewel lets the locking-spring fall, so that unless this difficulty be obviated, by something that Mr. Robjohn has not described, his invention is of no value, and will not answer the purpose for which he intends it.

"If Mr. Robjohn cannot show, in your next issue, how this difficulty is overcome, I think I may fairly claim priority of invention; and I will then describe how I apply it to my new style of marine chronometer before mentioned."

The above communication, which was dated in August, having been accidentally mislaid, we have referred it to Mr. Robjohn, who accompanies it with the following explanation:—

166 Bowery, New-York, Oct. 20, 1858.

DEAR SIR,—In reference to the point alluded to by Mr. M'Laughlin, it is found that in my escapement the locking-spring falls after being lifted by the lifted jewel, in an almost imperceptible time. In first experimenting, I used a locking similar to the one in my escapement, balanced on two pivots, with an upper and lower locking, so that when the fly passed off one, the other arm of the fly would be caught by the other, and held until the lifting jewel passed by. Finding it better to reduce the connection from two beats to one, I saw that the fly never came in contact with the lower locking, and, therefore, abandoned the detent locking, and applied the locking spring. Even then, I at first put another jewel a little below the locking jewel, to make safe, but as the remontoir fly is some time in advancing, the locking spring is in its place ready to receive it before it has accomplished one-half the distance.

Respectfully your ob't,

THOS. ROBJOHN.

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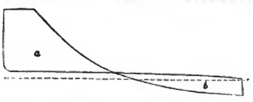
The Great Exhibition.

WE confess to a degree of reluctance with regard to attempting superficial notices of articles on exhibition. There is enjoyment in investigating for one's self—there is an equal or perhaps greater luxury in imparting information to others, but both depend much on the circumstances and conditions. A habit of close attention and thoroughness, which should always be scrupulously cherished under all circumstances, interferes directly to embarrass the light and running style which the multitude of deserving objects renders absolutely unavoidable. But the exhibition is now fully and fairly open; its every department is reported complete. The many who have waited its tardy commencement and gradual development may be now supposed to avail themselves of the long desired opportunity of seeing the exhibition in its glory; and imperious necessity compels a hasty sketch of some of the more deserving objects in the mechanical department.

The machine arcade stretches, as described in our February number, page 35, across the rear of the main octagonal building, nearly filling the narrow space between it and the inclosure of the massive Croton reservoir. It is 451 feet long, about 24 feet wide, and 24 feet high, exclusive of the picture gallery above. This space, with an addition to be noticed below, is filled in a manner reflecting credit on the taste, judgment and skill of the committee appointed to supervise the apportionment of space to this important class. As a whole, it is an exhibition of mechanism principally American, but surpassing any similar display which has yet been, or probably will be, attempted for many years to come.

The motive power is primarily derived from 6 plain cylinder boilers, 3 feet in diameter, by 40 feet long, located outside the building and across the street; the distance from the boiler to the building being 160 feet. The steam generated here is conveyed under the street in a cast-iron pipe of 8 inches internal diameter. This main pipe is continued to a point a few feet within the building, where the pipes are connected leading to the two principal engines. The minor engines, the gages, the working models, and other steam-consuming arrangements, are attached at such accidental points as are found most convenient, one small gas-pipe of ¾ inch bore conveying steam to a group at the distance of about 50 feet from this connection. The provision of a casting with a considerable number of blank flanges at the terminus of the main pipe, would have much facilitated the attachment of the smaller pipes, but no arrangement could well avoid a considerable degree of condensation of the steam. The main pipe crosses the street in a box of sawdust, and those leading to the engines are carefully clothed, notwithstanding which, the steam is reported "wet" under all circumstances, and at the extremity of the small pipes, particularly when several models are attempting to operate at once, more unfavorable circumstances could not well be imagined. The danger of accident, as well as the absolute insufficiency of space, forbade the locating of the boilers within or nearer to the building. Steam is kept up from 40 to 60 lbs. pressure.

There are in the exhibition 16 working steam-engines, reckoning all sizes and descriptions. Of this number, 4 are employed in driving the lines of shafting, and several others are attached to single machines, proportioned in some degree to their power. The largest is a beam-engine, by Messrs. Corliss & Nightingale, of Providence, R. I., with their rotary valves and adjustable cut-off, controlled by the regulator. The construction of these valves we may be able to show in a future number. The cut-off motion somewhat resembles that patented by Mr. Sickles, of this city. Our Jan. number, pages 10 and 24 of the present volume, show the operation of the Allen, the Allen & Wells, and the Sickles cut-off. The one in question differs from the Sickles principally in the fact that the fall of the valve-rod is checked by a cushion of partially-confined air, instead of water or oil. The similarity between their cut-off and the Sickles has been the occasion of a strongly-contested suit between the parties; and the able argument of the Hon. W. H. Seward, in favor of the former, was recently published in the New-York Tribune. The cylinder of this engine is 14 inches diameter and 5 feet stroke; beam solid cast iron, supported on each side by one cast-iron column, with two wrought-iron braces, or holding-down bolts. The beam and all the parts of this engine are designed for a larger cylinder of 20 inches diameter. It is properly a condensing engine, but the air-pump and condenser are removed. It would require about 2 gallons of Croton at each revolution to condense the steam, when cutting off at half stroke. Working as at present, uncondensingly, and cutting off as it often does at only from 3 to 6 inches from the commencement, the latter part of its stroke is no doubt performed under a considerable negative pressure; and an indicator applied under these circumstances would be likely to trace a diagram



somewhat approaching the figure annexed, in which the area *b* is negative, and must be substracted from the positive area *a*, to ascertain the actual power developed by the stroke. The steam having been expanded until its pressure is actually below the atmospheric, the piston is effectively resisted by the vapor left in the cylinder from the previous stroke. It is needless to say that the drawing in instead of blowing out of the steam, which, under these conditions, must first occur on opening the exhaust-valve, is in consequence simply of extreme expansion without condensation, and must be unavoidable, in any non-condensing engine, when working *very* expansively. This engine is much admired by all competent parties who have visited the exhibition.

In close proximity to this, which is near the extreme northeast end of the arcade, are placed a pair of highly-finished engines, from the Lawrence Machine Company (formerly the Essex Company), at Lawrence, Mass., G. McKay, Treasurer. These are horizontal engines, 14 inches diameter and 35 inches stroke, connected to the same shaft. These engines have no rock shaft; the cut-off valve fits on the back of the slide valve, both being worked directly from eccentrics, the connections being, in effect, by single rods jointed in the middle. These joints are supported by idle levers, which turn on a fixed pin near the base of the bed-frame. The supports of the shaft are worthy of note, being pedestals quite narrow at the base, but with long bearings, the latter being 14 inches long. The shaft (wrought iron) is at that point 5 inches diameter, the length being thus nearly three times the diameter of the bearing. That this is a decided improvement over the usual proportion cannot be doubted; and the extract on this subject in our last number, page 233, is recommended to careful attention. The bearing is elongated by simply allowing the metal to overhang in the immediate vicinity of the shaft, making a neck or shell, which projects on each side, embracing the shaft. The "side brasses," "wedge boxes," or "quarter boxes" (which latter we think they are more generally termed in the Eastern States), are kept to their work in the most usual manner, although but one wedge is applied to each box. This shop has won a reputation for effective, durable, and economical work, second to none in the country.

The third in size is a horizontal engine, from the Winter Iron Works, Montgomery, Alabama. If the engineers of England, with their corps of workmen trained during a lifetime in each department, have been taken aback by the workmanship from the young establishments of America generally, northern men have been equally, or still more astonished by this display from the swamps of Alabama. This engine, "the Southern Belle," is a perfect *chef-d'œuvre* of elegance. Skilfully and generally correctly proportioned, gracefully patterned down to the minutest detail, and profusely ornamented, it is equally an attraction to the sparkling eyes of the romping girl in pantalets, tugging at the finger of her paternal ancestor, the simpering Miss hammering her teeth with her fan while she admires the form reflected from its surface, and the more practised eyes of the experienced workman. Surrounded by every thing symbolical of industry, it is yet a poetic subject suggestive of every thing far removed from the stern reality of Adam's curse. The exquisite polish, the elaborate details, the defiant eagle surrounding the light Moorish architecture about the cylinder, is all so foreign to man's dread inheritance, the sweating brow, that even a momentary digression from our path at this point might be expiated by a more rigid monotony in the future. Dry details are not our design, however; we prefer to make each machine a reel on which to wind a thread of familiar but profitable conversation.

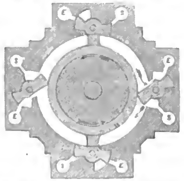
The cylinder of "the Southern Belle" is 12 inches diameter with 30 inch stroke; whole length of frame 17 feet; balance-wheel 12 feet in diameter; rim cast in one piece, with round, tapering sockets for the arms; arms wrought iron, covered with brass, which is cast upon them; hub, two flanges bolted together, with round, circular sockets between them, half in each to receive the arms. The balance-wheel is thus completed without a bolt, except in these flanges at the hub. The regulators of both this and the Lawrence pair of engines are peculiar, but all depending on the same principle, the varying relations of centrifugal force and gravity at the different velocities.

The palace has been enlarged beyond the original plans, as presented in the February number, by the recesses left between the ends of the machine arcade and the main building. One recess is employed as a mineralogical cabinet, the other is devoted to machinery.

A rotary engine of considerable size is employed in driving several wood-planing and other machines in the recess, which opens freely into the general arcade. This engine is contributed by the inventor, R. C. Bristol, Esq. of Chicago, Ill., and stands within a rectangular framing, 3 by 3½ feet, on the floor, the whole engine being about 4 feet high. The construction and general arrangement of this engine very closely resembles that of Colonel Barrows, which was detailed in our August number, page 169, with the exception of the valve motion. As in the Barrows engine, which is also on exhibition in another part of the arcade, a fixed cylinder lays on its side, with a smaller cylinder revolving within it. Two stout masses of metal project inward from the inner surface of the fixed cylinder, at opposite points, and fit steam-tight against the revolving cylinder or wheel within. Four gates or wings also project outward from the inner cylinder, and fit steam-tight against the outer one. The wings are free to slide radially, and are drawn in as they approach the fixed projections, and again thrust out after passing. During their passage, therefore, from the vicinity of one projection or abutment to near the opposite one, they are in position to feel the full force of the steam, which is continually admitted at one side of the abutment, and escaping through the same side of the opposite one. The volume of steam used in each revolution depends on the contents of the annular space or steam chamber between the outside and inner cylinders, minus the space filled by the pistons or slides.

So far they resemble each other; but the sliding wings or pistons are in the Bristol engine driven out by small pistons attached at each end, and operated by the steam. They are driven in again by meeting the sides of the fixed abutments, which are made inclined for the purpose, the steam which has been acting to force them out having been previously allowed to escape. The diameter of the outer cylinder of this engine is 24 inches, of the inner cylinder, 19 inches, the length of the working piston being 24 inches. Mr. Bristol works the steam expansively, but the cut-off valve being at some distance back in the steam passages, a loss of effect ensues. This loss is of the same kind as that which occurs in any reciprocating engine, when a separate cut-off valve is used with a considerable space between it and the regular working valve. As the steam in the chamber thus formed fluctuates in pressure with every stroke, first rising to the initial, and then falling by expansion to the final pressure, it is plain that some work *might* always be performed in the admission of fresh steam to fill this chamber. As the mode of calculating the effect of steam working expansively, although often explained, may still be not very familiar to our readers, we will treat the subject at some length in our next issue.

The revolving piston engine is the name given to a small working model of a rotary engine, exhibited by its inventor, B. H. Wright, of Rome, N. Y. The pistons or floats are two in number, diametrically opposite, fixed to a centre wheel, and moving in an annular chamber. There are four vibrating abutments or steam stops, peculiar in their form, position, and action; the steam being let on by means of four cut-off valves, working in pairs, one of each pair being actuated by an eccentric, and the motion transmitted to its companion by a connecting-rod. The steps or abutments, by the action of the steam in its passage to the pistons, are made to turn on their axis, and place themselves athwart the annular chamber. After this duty is performed there, they are removed again, in order to clear the way for the piston, by means of stems, which project through the heads of the cylinders, to which stems, tappets, or any analogous device are attached, the latter following up the inclined surface of a cam-wheel.



The placing of the fixtures designed to regulate the movements on the outside, where any variation can be promptly detected and removed, appears to us judicious.

Messrs. Wells & Hill, of Milwaukie, exhibit the stave-dressing and jointing machine, patented by William Hawkins. The work is done to both the sides and edges of the stave, by rotating cutters, the joints being always cut in the same bevel. The proper taper, from the middle toward each end, is given by a cam, which regulates the distance apart of the jointing cutters. A self-acting feed thrusts forward the wood at the proper moment, so that the swell is always exactly in the middle of its length. Staves are usually finished flatter than the proper form, the severe drying which they afterwards receive on the hollow side tending to make them assume a more curved form. This warping effect is greatest on wide staves, so that there is little necessity for varying the bevel of the edges. This is said to dress and joint 3000 48-inch shooks in a day of 10 hours.

Barlowe's Planing Machine, illustrated in our first volume, page 449, is in operation at a point near the centre of the arcade, and attracts much attention by the novelty of its feeding operation.

Two forms of the Woodworth Planing Machine operate in the extreme north corner, tonguing and grooving, and "sticking" mouldings. This much-contested and extremely important patent will expire Dec. 26, 1856, unless it be a *fourth* time issued.

Mowry's Patent Stave Machine, cuts, dresses, and joints staves to the tune of 90 a minute, jointing always to the proper bevel. This shapes a complete stave, by cutting it off at one stroke of a powerful knife, curved to a proper shape and moving with a proper sweep. The edges are jointed on the same principle by a couple of knives, which come up and score into the block, just before the main cutter makes its stroke, so that each stroke of the latter shaves off a perfectly-shaped stave. It detracts seriously from the value of this machine, that the wood must all be steamed before operated on, and is even then too much bent, strained, and split in cutting, to fit it for any but dry or "slack" work.

J. A. Fay & Co. Keene, N. H., exhibit some half dozen varieties of their almost indispensable wood-mortising and other kindred machinery. Messrs. M. & J. H. Buck, of Lebanon, same State, range by their side several mortising and tenoning machines; and, in general terms, it may suffice to say that the department of wood-working machinery is very well filled in almost every respect.

Chas. F. Mann, of Troy, N. Y., exhibits a vertical steam pump; the steam cylinder 5 and the pump 3 inches diameter, with 8-inch stroke. The pistons of both are on the same rod, as in the Worthington pump, but a slotted piece is attached between them, in which the pin of a crank travels in a suitable sliding-box, and by a balance-wheel on the same shaft regulates the motion. The steamship Great Britain has a pump similarly arranged, or had, when last here. One great merit possessed by this is, that the pump may be unshipped, and the crank driven as a steam-engine for any other useful purpose.

Joseph Harris, of Boston, exhibits a beautiful miniature beam-engine, with a whimsical attachment. It is a single engine, but the shaft has two cranks at right angles to each other, and a separate connecting-rod leads from each crank to the beam, or rather to the two ends of a small beam, which is hung by its centre to the end of the large one. The sensitive exhibitor shows a degree of industry in attending to this uselessly complex machine, better bestowed on a more deserving object.

G. B. Hartson & Co., Globe Iron-Works, this city, exhibit a centrifugal sugar machine, similar to those now in operation at the foot of Broome-street, expelling the fluid by whirling the sugar in an upright cylinder, with wire gauze sides. Cylinders of about 32 inches internal diameter, revolving 1000 times per minute, effectually clean their contents in 2 or 3 minutes.

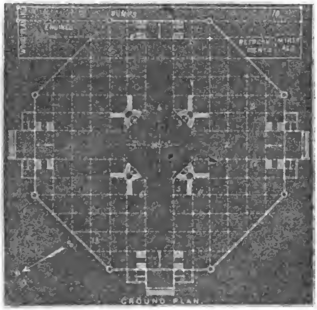
Patrick Clark, Rahway, N. J., exhibits a very simple apparatus for regulating the draught in the chimney for a steam-boiler. The pressure of the steam acts, through the medium of a piston or an elastic diaphragm, on a damper in the chimney, so that the damper opens or closes as the steam gets too low or too high.

A newly invented little machine for manufacturing roller cots, approaches in smoothness and beauty of its operation the "card-setting machine," formerly the lion among the smaller machines at every fair. This cuts, cements, and throws out perfect cots for covering the drawing rollers of spinning machinery, a very considerable labor heretofore performed by hand. The circular claims that over 25,000 cots are consumed in Massachusetts per day. On the usual estimate of four cots per year for each roller, there are nearly twice that number consumed.

The Hadley Falls Company have on exhibition the various applications of Dick's anti-friction press, one of which shears for cutting boiler plate, is accompanied by a plate between 3-4 and 7-8 inch thick, from which it cuts a strip occasionally, by way of showing its power.

Wood's patent imitation Russian sheet iron, from the M'Keesport Iron-Works, Alleghany county, Pa., presents a surface very closely resembling the imported article.

A variety of models of brick-moulding machines are located near the centre of the arcade; and sewing machines are located almost everywhere. The passing visitor may notice, with some interest, a handsome specimen of the nail machine, called after the inventor Jesse Reed, and the kind on which the greater quantity of small nails and tacks consumed in the world are manufactured. Near it are the models of bridges, of which there are some five or six, in both wood and iron; one of which, a railroad suspension bridge, exhibited by Wendell Bollman, we would especially notice. It appears to combine stiffness, strength, and economy of material, to a degree entitling it to careful attention.



We will conclude the sketch this month, by denoting a few general objects particularly worthy of attention, making one plan serve for both first floor and gallery.

1 (*in gallery*). A case of small fish, without eyes, from the mammoth cave of Kentucky.
2. The Fresnel lantern, to throw all the light into a horizontal plane.
3. Kiss's Amazon attacked by a lion; a copy of the famous one at Munich—very spirited.
4. Hiram Powers' world-renowned statues, Greek Slave, &c.
5. Gobelin tapestries, woven to imitate (or excel) paintings.
6. Mosaic table, and a mosaic portrait of St. John, valued at $60,000.
7. Bust of John Ericsson—very natural.
8. Two very large sheets of boiler iron; one round, 92 inches diameter.
9. (*in gallery*). Miniature beam-engine, and an oscillating engine standing on an English fourpenny piece. These have been lauded by the press beyond their merits; they are infinitely inferior to
10. A beam-engine and boiler, by a boy in Pennsylvania. Weight of whole, with smoke-stack and foundation, 9 dwt. 12 grains.
11 (*in gallery*). Gulliver among the Lilliputians—don't fail to visit it.
12 (*in gallery*). Tulip of precious metals and jewels.
13. Daguerreotypes of many of the most distinguished individuals now living.

Apprentices' Department.

Answers to Questions on page 239.

24th. 770 lbs. is the force required to raise the valve.

25th. The total area of opening or steam-way is 97·929 square inches.

26th. The force tending to compress and crush the thimble is about 6729¼ lbs.

Question 23d, on page 215, is open for another month. Can no one answer it? The earth may be assumed to be a perfect sphere, and the latitude of the tower may be considered 49°.

Questions.

Question 27th. An active man can, by his own muscular effort, raise himself to the highest floor of the Latting Tower, *i. e.* 270 feet, in 6 minutes of time. What portion of a horse power does he exert during this spasmodic effort, assuming his weight to be 150 lbs.?

Question 27th. An amateur boat-builder of our acquaintance, in constructing a new boat, had the thwart which supports the mast placed much lower than usual, so as to give the wind less purchase to overset the boat. The circumstance raised a dispute among the neighboring boatmen with regard to its efficiency, one party contending that the improvement made the boat stand up stiffer and with less liability to break the mast or its fastenings, and another asserting that it did not materially affect either of these important qualities; What is the right view of the case?

Monthly Notes.

Since the issue of our last number, we have intelligence of the accomplishment of two objects of considerable general interest to the civilized world. Com. Perry has arrived with the American squadron at Japan, landed and been received by immediate representatives of the Emperor, produced an apparently good impression, and left the islands to return in three months for an answer to the letters delivered. H. B. M. ship Investigator, Commander McClure, has also entered the Northern Ocean, at Bhering's Straits, *performed the Northwest Passage!* and emerged through Barrow's Straits into Baffin's Bay. The former is an initial step toward the accomplishment, by the American navy, of the greatest commercial object of the age; the latter adds to the laurels of England by resolving a geographical question, which has been the object of so many expeditions from the days of Ferdinand and Isabella to the present. Whether both or either will be of any material value depends on the result of future movements.

The vacancy in the office of Engineer-in-Chief of the Navy was filled on the 18th of the month, by the appointment of Daniel B. Martin, one of the oldest of the chief engineers now in the service.

The Secretary has delayed so long, for the evident purpose of choosing one fully qualified to fill this important post, that it becomes interesting to the engineering world to know something of Mr. Martin's history as an engineer. From 1828 to 1842, when he entered the navy as Assistant Engineer, he was in the employ of Robert L. Stevens, in his line of steamboats running between Philadelphia and New-York. After five years' service in the navy as first assistant, he was promoted to a chief engineer in 1847. In 1848, he took charge of the construction of the engines and boilers of the steam-frigate "Saranac." She was completed and went into commission early in 1850, and he remained as her chief engineer until August of that year. At the request of E. K. Collins, Esq., he then, with the permission of the Department, went as chief engineer of one of the ships of that line, and remained in her two years. He was the first to bring the ports of New-York and Liverpool within ten days of each other, which he did with the Pacific, in May, 1851; and the Pacific was, for the time, the crack boat of the American line.

When the Arctic was first put into commission, it will be remembered that she did not come up to the expectations of the public, or of her projectors. Mr. Martin, however, was transferred to her, and, having designed and executed such changes as he conceived necessary, performed in her, in the stormy month of February, 1852, the quickest trip that has yet been made. And as an example to our young engineers, we will state, that during the whole time he was in the Collins steamers, it was his uniform practice to visit the engine-room during some part of each watch. It is his untiring industry, united to his good, sound judgment and long experience, that has enabled him to carry out with such signal success every thing that he has undertaken.

In August, 1852, the Department required his services, very much to the regret of Mr. Collins, who wished to retain him. During the past six months, while many were striving with the utmost efforts to obtain the post he now fills, his name was never, with his permission, mentioned to the Secretary in connection with it, and the first conversation the Secretary had with him on the subject, was to notify him that he had appointed him.

We have contended for a practical engineer as chief of this department; but Mr. Martin possesses within himself a thorough theoretical as well as practical knowledge of his profession—qualities rarely found combined in the same individual.

Our steam navy has justly acquired a reputation for inefficiency, which renders it almost a disgrace to the nation. From Mr. Martin, if properly supported, we expect much toward retrieving its character.

Our August number, page 177, details a Russian apparatus for obtaining gas from wood or turf. Recent experiments at Bavaria have shown that carburetted hydrogen gas, obtained from wood, is not only equally efficacious as that of coal, but much cheaper in countries where forests are abundant. Some of the Bavarian towns, remarks the London *Civil Engineer and Architect's Journal*, have added a clause to their contracts with the coal-gas companies to the effect, that the bond will become invalid, if gas can be obtained at a cheaper rate from any other source.

In excavating some railway cuttings, near Lyons, a number of remains of Roman houses have been discovered, apparently destroyed by fire. Further excavations are being made, some antiquarians surmising the location to be that of the village of Lunna, mentioned in the Itinerary ascribed to the Emperor Antoninus. Some recent excavations in the northern part of Russia have brought to light a road paved in the ancient Roman style, existing a few feet below the surface.

England has lately ordered an allowance of retiring pensions to her naval engineers. Inspectors afloat are to receive from £130 to £150; chief engineers, who have served 12 years in that rank, £100 to £130; after 6 years, £85 to £105, and after 3 years, £75 to £90; assistant engineers, after 20 years' service, from £50 to £60; and after 8 years, from £40 to £50.

Our illustration of the Woolwich reverberatory furnace and of Montgomery's corrugated boiler, need no especial description. The former will be appreciated by all interested, being a rigidly exact drawing of one of the largest and best furnaces of the kind in existence. The latter is designed to furnish a very much increased amount of fire surface, without increasing the unproductive surface at the bottom of the flues.

The boiler represented has four furnaces, with two direct and six return flues. It presents about 1342 square feet of fire surface, while a corresponding boiler of plain iron would present but about 1208 square feet. This includes the bottoms of the flues, and excludes the corrugated surface in the steam chimney above the 12-inch water line. The difference between the *effective* heating surface, excluding the almost useless bottoms, would be, of course, still greater. "Mone's Treatise on American Engineering" contains a detailed description and full drawings of this boiler.

Corsets have at last found a champion, in the Academy of Medicine at Paris. Dr. Bouvier has made a report to that body defending the use of corsets, as an article of ladies' dress, maintaining that "the volume of the bosom, the relaxation or the distention of the muscular wall of the abdomen, the habitual bending of the trunk, the lateral deviation of the spine, &c. give formal indications for the employment of this sort of bandage, whether upon hygienic principles, or as an aid to cure certain lesions." "This," adds an American work of some note, "is the most sensible view of the subject; and it is a remarkable fact that 'abominable supporters,' as Dr. Meigs calls certain instruments, have been only brought into use since the senseless hue and cry made by medical neophytes against the wearing of corsets. They have doubtless been abused, when fashion has dictated their excessive tightenings, but they are innocent and useful, when judiciously worn."

The patent granted to Mr. Isaac Babbitt, of Boston, in 183–, for his mode of fitting soft metal linings to bearings, has been recently extended, and notice has been issued that he shall prosecute all infringers.

The experiments or mixtures of steam and stame, alluded to in our last number, page 239, have been considered sufficiently satisfactory to justify the application of the superheating apparatus to the boiler of a large steamer, the Joseph Johnson, the contract for which is now being executed. These interesting experiments have been conducted under the patronage of E. K. Collins, Esq., agent of the Liverpool line of steamships, and our readers will be put in possession of the details as soon as sufficiently ripe for publication.

The trial of the owners and officers of the steamer "Henry Clay" is now progressing in the U. S. Circuit Court in this city, before the Hon. Judge Ingersoll. The testimony does not materially differ from the accounts published at the time, except that some respectable witnesses judged that every thing was done by the officers and owners for the safety of the passengers that could be done.

We take this occasion to remind the curious among our readers, that the nights of the 12th and 13th of November have been noted as being remarkable for displays of meteors, or shooting stars. Modern science has so far failed to suggest any reasonable theory for their existence, or to establish any laws by which they are governed, further than to observe that they have periods of maximum frequency. One of these is January 2d, another April 23d, again the middle of June, 10th of August, 18th of October, and 7th of December. The greatest of all, however, is in November of each year. The number of shooting stars is thought to be decreasing each year.

Shooting stars move in every direction, many moving *from* the earth. The fact that the same meteor is often seen by persons at points very remote indicate a considerable height and velocity to these apparently inconsiderable fire balls. Two students at Gottingen, in 1798, stationed themselves nine miles apart, each with an accurate chronometer and a good map of the heavens, and accurately noted the time and path of every shooting star they observed. Some were not seen by both, but of those which were, a comparison of their observations furnished the data for computing their distances. Since that time more nice observations have been made by great numbers distributed over a large area of country, and the result has proved that many of these phenomena occur at heights of 550 miles above the ground, being, of course, far above the limits of the atmosphere.

The Directors of the Crystal Palace have announced the intention of keeping open the exhibition throughout the entire winter. The public are beginning to appreciate its merits; and as a pecuniary speculation, it promises to be much more successful than in its former imperfect condition.

The Fair of the American Institute, at Castle Garden, was not kept open for so long a period as usual, owing to the existence of the greater attraction up town.

Barrows' Steamer "Rotary" was on exhibition during the latter portion of the time, plying about the vicinity to exhibit her engines to any parties interested. The engine was taken apart, the better to show its construction and wear, and excited much admiration from the engineers present. The gold medal of the Institute was awarded to the inventor.

A correspondent of the London Builder, adverting to the disagreeable heat produced by the gas-lights in any well-lighted apartment in warm weather, suggests an extra pipe to accompany the gas-pipe, for the purpose of conveying air from the external atmosphere to supply each burner. He lays down the proper proportions of the pipes as follows; gas 2, air 5. The Journal of the Franklin Institute takes up the idea, and commends it to attention. We have stated the whole plan as it is published; but outlets for the heated air, are, of course, understood as part of the plan, and in our humble opinion the essential part. We would recommend the plan adopted in the new Tremont Temple, at Boston, as very near perfection. The lights are all placed in the ceiling. Each is provided with a chimney leading out through the roof, liberal openings being made in other parts of the room to admit air, the air being heated or otherwise, as the weather may require. This insures proper and certain ventilation; and reflectors from each burner throw a soft, brilliant light over the room, without inflaming or annoying the eyes.

The American Polytechnic Journal objects to the use of the word "physicist," as being new coined, difficult to pronounce, and uncalled for. We agree perfectly to all but the last objection. Some word is wanted more narrow and definite than philosopher, yet more broad, comprehensive, and convenient than "engineer," "mechanic," "natural philosopher," "amateur in physical sciences," &c. We want a term which shall include all the latter, and yet exclude theological and speculative philosophy. We have several times used the French word "*physicien*," but invariably see it copied into our exchanges as "physician"—a meaning very far from its intent. We recommend "physicien" to all writers on physical sciences, as a word which is or should be already adopted into the nomenclature of mechanics and engineering, and would here give its French definition, but have already done so above. Do not understand it as doctor, until the mass of medical men are much better informed in natural laws than at present.

New Publications.

The Engineer and Machinist's Drawing-Book. Blackie & Son, London, Edinburgh, Glasgow, and New-York.

A work now in course of publication. It is intended to be complete in 14 numbers, of which 6 are already issued, and lie before us. The work is of "imperial quarto" size (11 by 15 inches), and is evidently well planned and admirably executed in every respect.

It is based mainly on the treatise of Le Blanc, and his modes of demonstration and illustration are adhered to throughout, but incorporating a considerable amount of other and valuable matter. It is as its name purports, an *Engineer* and *Machinist's* book, rather than a teacher of Architectural or Topographical Draughting, and holds forth on its cover the somewhat too broad promise of "a complete course of instruction for the practical engineer"—a pledge which appears to be made good, however, so far as practicable, in a work of this kind. Its illustrations of finished machinery are from the latest and best examples—a point often not sufficiently considered in elemental works; and though English or French in all its styles, the fact detracts but comparatively little from its value. Each part contains 4 or 5 full page plates, and 8 pages of text, interspersed with numerous wood engravings. The nature and use of instruments, construction of geometrical figures, shade lines and shading, projections and perspective, penetrations and intersections of solids, are all made preliminary to entering upon what is more especially drawing of machinery, which latter is but just commenced in the sixth number. We shall take occasion to allude again to this book, as it progresses, but feel no scruples in recommending it most unhesitatingly. It may be obtained from the agents of the publishers, or through any responsible bookseller.

To Readers and Correspondents.

Major Barnard's article in the present number will probably close his very thorough mathematical analysis.

The language used by Major Barnard, toward the close of his July article, might lead to the conclusion that he disbelieves in the practicability of using heated air *at all* as a motive agent. This, as we are assured by Major B. himself, is, however, not the case. *Theoretically* he concedes that air has largely the advantage of steam in economy of heat; but there are, however, *practical* difficulties in the way of its employment, which have thus far caused the failure of every attempt.

These practical difficulties may yet be overcome. The experiment of Captain Ericsson has, at least, had the effect of awakening the attention of scientific and practical men to the subject, and we may soon hear of a successful hot-air engine, even if the ones now being placed in the ship should be inefficient.

A short paragraph on page 259, commencing with "In all the operations of nature," embodies a great idea, in a very few lines, and may be worth twice reading.

Is "M" right in attaching much importance to the supposed presence of hydrogen in warmed rooms, so long as the iron, which is supposed to do the mischief, by decomposing the vapor, is not sensibly oxydized?

"Artisan," N. J. Perhaps the best method of obtaining alcohol, absolutely pure, is that published in *Jour. de Chim. Med.*, 1846, which is briefly thus:—

Strong alcohol is to be saturated with chloride of calcium, and the portion first distilled from it is to be treated with perfectly dry sulphate of copper. The dry salt in combining with the alcohol recovers its blue color, and when this color ceases to be produced, water is no longer present.

"G. M'V.," N. H. We confess at once to an immense amount of ignorance on the whole subject. It is a popular belief that the forms and sizes of waves are affected by the density, but how, why, and how much, has not been recorded, as we are aware. The fact that a few observations by Dr. Scoresby (see vol. i. p. 32), when a passenger on a steamship, have been copied extensively and preserved with interest, is sufficient proof of the paucity of observations. Lieut. Lynch, U. S. N., who explored the Dead Sea, in 1848, speaks of seas like "the sledge-hammers of Titans;" but the gale suddenly stopped, and the waves sunk at once to rest. In five minutes the sea was unmoved, even by undulation. He ascribes this truly remarkable effect to the saltness of the water.

"W. M. Jr.," Mass. The "American Association for the Diffusion of Science" first met as such at Philadelphia, in September, 1848, but it had been in existence as an association of geologists, or of "American Geologists and Naturalists," some eight or nine years previous.

"A. B. G.," Pa. The only calculation on the subject, we recollect to have seen, made the whole amount of heat from the sun absorbed in evaporation, equal to melting a bed of ice about 85 feet thick, spread over the whole earth.

"T," Ohio. Although pleased to learn by such assurances that the past conduct of our journal has been acceptable, the favor would be more acceptable, and probably more substantial, if you would take pains in recommending it to your friends.

"J. P.," N. Y. We agree with you almost perfectly, and shall present your letter next month. Should you visit this city, let us "compare notes" with you.

"R. V. M.," R. I. We have a prejudice in favor of hemlock-tanned or second quality leather for belting, but shall treat the subject at some length in our next issue.

"L.," Canada. It is always much more agreeable to have the real name of a correspondent, if only confidentially. Your suggestion appears practicable, however, and we will present it in the next number.

"A. L. B.," N. Y. The only way is to attach yourself in some subordinate capacity to some engineering corps, and rely on your capabilities, and the practice thus obtained, to raise you. No particular degree of skill is implied by the title "C. E.;" you may assume it now if you choose.

BRISTOL'S ROTARY STEAM ENGINE

R. C. BRISTOL, PATENTEE, CHICAGO, ILL.

Fig. 1.

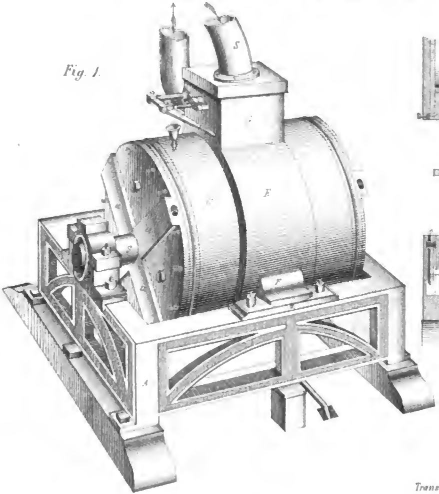
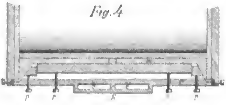


Fig. 4



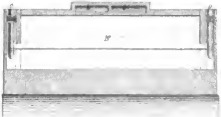


Fig. 5

Transverse Section on the line e e

Fig. 3.

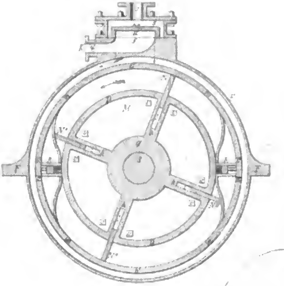
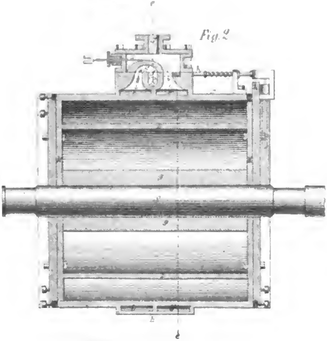


Fig. 2



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APPLETONS'

Mechanics' Magazine and Engineers' Journal.

No. 12.—Vol. III.—DECEMBER 1st, 1853.

BRISTOL'S ROTARY STEAM ENGINE.

Plate XIV.

The Rotary Engine employed in the Crystal Palace during the earlier period of the exhibition to give motion to the large wood planing and other machinery, in the recess, at the extremity of the machinery department, is the subject of plate XIV. It is similar in almost every respect to the one in use as an auxiliary engine on board one of Ward's line of steamers, plying between Chicago and Detroit, and is the invention of Richard C. Bristol, Esq., of the former place, who obtained a patent in July last. The engine has been also patented in France and England.

We disagree with many, doubtless a majority of our brethren, who consider rotary engines impracticable, and at all events, destitute of advantages. It is theoretically possible for a rotary to be more economical, both of space and of steam, than any reciprocating engine. Waiving entirely the questions of constant, as compared with intermittent power, the loss by the crank, &c., on which many ridiculous views have been advanced by either party, a desirable rotary may be, and has been discovered. Our August number, page 169, details the engine of Ebenezer Barrows, which we have since seen several times in active operation with a pressure of less than 1 lb. by Eastman's gauge. The Barrows engine is undoubtedly unsurpassed, if not unsurpassable, as a practical and convenient rotary engine, rendering available the whole measure of steam generated, without loss in passages, and causing no trouble in its working. There are some points, however, in which this engine by Mr. Bristol excels, in theoretical perfection, even that of Col. Barrows, among which are provisions for working the steam exclusively, and for rendering the whole self-adjusting to the shaft.

Fig. 1. plate XIV, is a perspective view of the engine as finally improved by the inventor, being somewhat simpler in appearance than that in the exhibition. The outer cylinder or case, in which the steam wheel with its wings revolve, hangs rather delicately, but firmly, by two lugs marked F, with liberty to play or incline in any direction, or to oscillate slightly to adjust itself to any bends or misplacement of the shaft. Fig. 2 is a vertical longitudinal section, and figure 3 is a transverse vertical section. The same letters of reference indicate like parts.

A is the frame of the engine; B B are the journal boxes for receiving the main shaft, S, to which the revolving part of the engine is secured; C, is a cylinder; it is bored true, faced at the ends and is surrounded by a steam case, E, which is furnished with two lugs, F F; the lower surface of these lugs are slightly convex and rest on suitable bearing plates, *a*, which are adjustable by set screws to adapt it to the bearing surfaces of the shaft, S. The double steam case, E, has two passages, b b', (figure 2), both encircling the cylinder, but independent of each other, the one communicating with the interior of the cylinder, by openings, *c*, and *d*, the other communicating with the same through c' and d' (same figure). Either of these passages are used as a channel for the steam (the other serving as exhaust), the choice being decided by the position of the slide valve, H. On the top is the steam chest, G, which is supplied by steam from the boiler by pipe, S. K is the exhaust pipe, to receive the spent steam through the exhaust port, *f* (figs. 2 and 3). $N\ N'\ N''\ N'''$ are four sliding pistons. They are set in slots, *l l l l*, of the steam wheel, which is composed of cylinder, D, having a hub, *g*, secured on the shaft, S. R R are two fixed abutments attached to the fixed cylinder, C; these have packing bars, *m m*, which are adjusted by screws, *p p*, to press steam tight against the rotary cylinder. The cylinder, C, being stationary, the steam acting inside of it on the sliders $N\ N'\ N''\ N'''$, moves the wheel composed of D, *g*, S, with its ends, arms, and sliders, forming the rotating parts of the engine. When the engine is running, it takes its steam by only one of the slide valve ports, and is shown in figure 2, to be taking it by the passage, *t*. When moving in a contrary direction it takes its steam by the passage, S, where it is now shown exhausting the steam through the cavity of the side valve, H, and through the exhaust port, *f*, into the pipe, K. The slide valve for reversing the motion of the engine, is worked by a lever, I (fig. 1).

The steam is now shown as admitted through the ports c' d' on both sides of the engine, those at the right hand side, figure 3, on the upper side of the abutment, and on the left side beneath the abutment, making the engine rotate in the direction of the arrow. Of course the steam exhausts at the right hand side through the ports below the abutment, and on the left hand side above the abutment.—When the engine is moving in a contrary direction, the present steam passages become the exhaust passages.

The general arrangement of the engine will now be readily comprehended. The sliders, $N\ N'\ N''\ N'''$, are in turn forced out across the chamber, or space, which exists between the fixed cylinder, C, and the revolving cylinder, or steam-wheel, D. In that position, each feels the full force of the steam until it has passed one of the exhaust passages, D, when it is at once relieved of all pressure, in any direction, and is immediately afterwards forced in, by meeting the inclined surface of the abutment, until its edge is flush with the periphery of cylinder D. In this position, it passes the apex of the abutment, or the abutment proper; after which it is again forced out, pressing slightly, with its outer edge, on the other inclined surface of the abutment until it is again fairly resting against the interior of the cylinder, C, and supporting the full pressure of the steam. In other words, each slider rides up on one side of each abutment and down on the other, the sides of the abutment being shaped with an easy curve to facilitate the operation.

It will be seen on attentive examination, that each slider, when in motion, outward or inward, is in perfect equilibrio with regard to the pressure. It does not commence to draw in until relieved of the pressure behind it, and in sliding outward both sides are alike subjected to the full pressure, so that the friction attending this very important operation is necessarily trifling. A sufficient amount of play is allowed to enable the steam free passage between the annular working chamber, and the small spaces, *l l l l*, so that the motion of the sliders is neither assisted nor repelled by the force of the steam on its edges. It remains to be seen what means are devised for forcing out the sliders, which, although not particularly resisted, would of course require some efficient means to insure prompt and certain action, in all cases, and under all circumstances.

This is accomplished by the direct force of steam acting in small separate cylinders, near the end of each slider. Small pistons, *o o*, in these cylinders are connected to projections on the ends of the sliders, and feel the force of such steam as may at the time be in its corresponding cavity, *l*. At the time when any slider is required to be thrust out, it is surrounded by steam at full pressure, which acts on the small pistons at each end, and when all is properly adjusted, insures the prompt movement of the slider in following down the steam side of the abutment. This portion of the operation is somewhat open to objection, as all excess is not only waste of steam, but produces friction in driving out the sliders, which, if carried to extremes, might be injurious. The relative size of the small cylinders, as compared with the main one, must depend somewhat on the pressure designed to be usually employed in the engine.

The principal features of the engine, so far as they resemble that of Col. Barrows, were fully discussed in our August number, page 169. The Rotary was there compared with the reciprocating engine, and we will here confine ourself to the points of difference between this and the engine then presented, which may be found to consist in the following:—

1st. The method of fixing the engine to admit of ready adjustment, or of self-adjustment to the line of the shaft.

2. The method of moving the sliders or wings out and in, and the fact of their moving under a balance of pressure.

3. The application of a cut-off and consequent expansive working of the steam.

4. The absence of packing about the sliders.

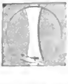
5. The different methods of reversing, and other details of little importance.

On the first point, much might be said with profit, but a few months of experience would be of more decisive value. The fixed cylinder of the Barrows engine is adjusted firmly in its place, and the shaft must be kept in its centre. In Mr. Bristol's, on the contrary the cylinder is supported by the two lugs alone, and rests endwise against the packing on the cylinder heads. The cylinder is otherwise at perfect liberty to adapt itself to the shaft, and to follow it about should it be allowed to get misplaced. We have said that the fixed cylinder is supported by the lugs, F, F, and by the packing rings at its ends, we should add the abutments which project inward from its sides, and by bearing fairly and steadily against the inner cylinder or steam wheel, assist in maintaining its perfect concentricity. Mr. Bristol's engine obviously appears to be superior in this respect, although under certain conditions, its operation, where it might be exposed to other strains, as in a steamer in a heavy sea, might increase rather than relieve the difficulties.

The method of giving the necessary sliding motion to the wings is the great feature of the invention. Being driven outwardly by steam, their edges are perfectly free to adjust themselves to the interior of the cylinder or to the inclined sides of the abutments with sufficient tightness without packing: the edges of these wings should have been rounded in fig. 3, as they would soon acquire such a form, even were they not originally so constructed. The steam, which, acting in the small cylinders, *o o*, presses the slider outward radially, is allowed to escape with the exhaust before touching the abutment. The perfection of this operation, however, must be a work of time, and it may be assumed that the Bristol engine worked very rapidly would maintain an almost continual pressure in the small cylinders, making them almost equivalent to springs. This is of little importance so long as the motion is obtained, the friction of the sliders against the sides of the abutments alone being somewhat increased; but at ordinary speeds the operation is proved to be nearly perfect.

A difficulty is found in practice to arise from the occasional refusal of the small pistons to act, or rather their failure to bring out the slider in time to be of effect. This, although never occurring when properly adjusted, occasions trouble when the small cylinders have been lately and tightly repacked; or when, from any cause, the pressure has been allowed to get particularly low. The slight uncertainty in the working of this part, is, in our view, the greatest, in fact the only serious objection to the plan. Its extent may best be proved by practice.

The application of the cut-off valve is somewhat different in our engraving from that in the Exhibition. The engine there running, cuts off by a single rotary valve in the steam passage above the valve chest. The valve employed is represented in the accompanying cut. The cut-off valve delineated in our plate is designed as an improvement, and although not very clearly represented, will be readily understood as a slide valve working in a cavity beneath the main valve, H (fig. 2 only). It is opened by a cam on the cylinder end, and closed by the coiled spring. The time it is kept open depending on the form of the cam, *h*, which is made adjustable.



It will be noticed that Mr. Bristol depends on the uniform wear of the metal to maintain steam-tight joints at the lines of contact of all the wearing surfaces, without the intervention of packing. Unlike the reciprocating engine, which allows any hard place in either the piston or the cylinder to eat into the other by continual and repeated contact, the rotary motion insures, in his view, an equal wear on all its parts, and consequent perpetual tightness.

The packing bars, *m m*, of the abutment, are tongued together, see fig. 4, and kept to their work by set screws as there represented. The quoin pieces extend the packing bars, compensate for end wear, and keep tight joints in every direction.

We give the preference unequivocally to Col. Barrows' engine as the best Rotary ever yet constructed; such, however, may not be the conclusion of all, we have therefore given both a full description.

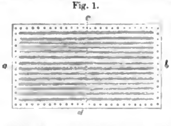
◆

Corrugated Boilers.

Since the the issue of our last number, a company has been incorporated, with a capital of one million dollars (Joseph Belknap, Phœnix Foundry, President), for the manufacture of corrugated boiler plates, on the patent granted to Richard Montgomery, in May last. Our last number exhibited a section of a return flue marine boiler, having the flues and fire-box constructed on this patent. It was presented simply as a new invention of interest; and in the monthly notes, page 263, brief allusion was made to its most prominent feature—the increase of fire surface. The subject now deserves a more thorough examination, and we will canvass it somewhat in detail.

A sheet of corrugated iron is of the same size, weight, and (says the inventor) of about the same cost as a corresponding sheet of ordinary iron. The edges are in no case affected by the process, but are left plain, to facilitate the riveting. A sheet of plain boiler iron, after being rolled down to the required thickness, is passed successively through the different corrugated rolls, till it is corrugated to any depth required, but always leaving the edges intact, in which to punch the holes for the rivets, as represented in Fig. 1. The necessary strength, ability to withstand calking, &c., is thus preserved in the border, all the original metal, and no more, remaining in the space inclosed. It follows from this method of corrugating, that the weight of a boiler of any given size and form is not affected

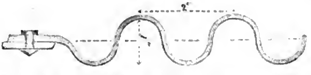
Fig. 1.



in the least by the substitution of the corrugated for the plain iron, nor is the labor of riveting.

The increase of fire surface is sufficiently obvious, and, although the main point, it requires but a passing word. The percentage of increase depends on the depth of the corrugations. The corrugations may be made of any depth required, from a slight wavy undulation to a full Roman O G, or even much deeper, the limit being found in the rapidly decreasing thickness of the metal. The only corrugated boiler iron yet in use, to our knowledge, is of a depth equal about half the breadth of the corrugations; its cross section consisting of a series of plain arcs, struck by the dividers, as in Fig. 2.

Fig. 2.



Although the patentee, we think, recommends corrugating to a depth equal the breadth between the prominences, which latter he always has made two inches. It remains for still further experiment, and perhaps the lapse of considerable time, to develope the proper proportion between breadth and depth to be adopted, under different circumstances, or perhaps some true mathematical relation, which should under *all* circumstances exist.

The diminished thickness of the corrugated plate, when not carried to excess, is beneficial, by allowing the heat much more readily to permeate. In short, corrugating iron gives it more fire surface, and, at the same time, makes that increased surface more sensitive. We are not aware of any experiments tending to prove directly the effect of thickness on the value of heating surface in steam boilers. Assuming a given amount of water per hour to be evaporated on a square foot of furnace-crown one inch thick, how much would be evaporated were it half an inch, or 1-1000 inch thick, with the same fire? There are no means of settling it theoretically; but it is plain that decreasing the thickness is equivalent, in one respect, to making it a better conductor—it has less distance to be conducted.

The irregularities thus formed on the interior of the flues, although not sufficient sensibly to affect the draught, create eddies favorable to a more intimate contact of *all* the products of combustion with the metal, and consequently with the water. The smoke and flame may be fancied to roll around in these corrugations, successively bringing all portions to the outside, and preventing any thread of hot flame from passing through the middle of the flue without effect. We attach little force to this point however.

A serious practical difficulty, attending the construction of boilers from this iron, lies in the bending and fitting of the plates. Corrugated iron is immensely stiff and unmanageable in the direction of its length, and the ordinary bending rolls would injure its form. The few plates now in use were curved at the rolling-mill, where it can be done with great nicety, if required, and to any radius desired; but to work the material properly, every boiler shop must have a set of corrugated bending rollers, somewhat approximating the proper form of corrugation. With a uniform *breadth* of two inches between each ridge, the providing of all the apparatus for conveniently working the plate would not be difficult or expensive.

The stiffness of the corrugated iron, however, adds a feature of strength of importance scarcely less than the increased and thinner fire surface. In all cases where flat surfaces have to support a pressure, as at the sides and tops of fire-boxes, sides of outer shells, &c., the resistance thus obtained to counteract any change of form is almost invaluable. Its advocates have probably claimed too much in assuming no stays to be desirable in supporting the sides or arch of a furnace, but their *necessity* is certainly very nearly obviated. The ability of corrugated iron to withstand strains of this kind has been sufficiently shown in other applications, particularly to roofs and life-boats, Francis' corrugated boats having been hundreds, if not thousands, of times subjected to blows of the severest character, without scarcely the slightest indentation. Corrugated iron at once does away with the wilderness of stays which encumber the high-pressure boiler, and may render practicable many improvements, which have heretofore existed only on paper, or perhaps have not yet suggested themselves to the most active imagination.

Facts on every subject must accompany or rather must precede reasoning. The results of experiments on the strength of corrugated metal have never, to our knowledge, been generalized into formulæ, and we can only deal with isolated cases. A pamphlet circulated by the proprietors of the patent contains the following, which we transcribe entire, leaving each to draw his own conclusions:—

> "A boiler six feet long was prepared in New York, the flue of plain boiler plate *one quarter* of an inch thick and *nine inches* in diameter, the outer shell of corrugated iron *one eighth of an inch* thick, and twenty inches in diameter. Hydraulic pressure was applied to the boiler, and the *flue collapsed*, without affecting the thin outer shell of corrugated metal."

Four strips of boiler iron one fourth of an inch thick and 7 feet 11 inches in length, were tested in New-York in the following manner:—

> "Two of them were bent in the form of an arch in the direction of their length, the remaining two strips were corrugated by passing them through rollers of the required shape, the rise of each corrugation being one inch. The curved ribs were placed in pairs, side by side, and weighed with pig iron. The first pair, consisting of plain iron, yielded with a pressure of 8126 lbs; the pair of corrugated strips were loaded with 16,094 lbs., and afterwards with 27,000 lbs., without any perceptible deflection."

The following test was applied at Washington:—

> "Two cylinders—one plain, the other corrugated—each 26 inches long, 21 inches in diameter, and one eighth of an inch thick. A framework was prepared, which covered the entire length of the cylinders and one third of their diameter. This framework was placed on top of the cylinders, and loaded with pig iron. The plain iron cylinder collapsed under a weight of 1100 lbs. The corrugated flue was weighed with 17,000 lbs., and remained several days under that pressure without any deflection."

The great point of failure in our present forms of boiler is in the collapsing of flues. The thickness of metal cannot well be increased, as in such case it scales and burns. Of all the accidents to steamboats, which are so numerous on our American rivers, from 50 to 75 per cent. are due directly to the collapsing of flues. This source of danger may be entirely obviated by the corrugated iron, while the metal will at the same time be thinner and lighter.

With regard to direct tensile strains, the new material possesses a much greater strength in one direction than in another. It may not have occurred to the reader, but is nevertheless true, that the strain on the shell of a boiler is similarly unequal. We could readily demonstrate, in a very limited space, what the unassisted reflections of the intelligent reader will render unnecessary, that the strain on any given point in the surface of a cylindrical boiler is twice as great in one direction as in the opposite. If they imagine such a boiler of whatever length or diameter divided into a great number of strips or staves, lying lengthwise, there is a certain force tending to sever these staves. But if the boiler be supposed divided into rings or hoops, in a direction at right angles to the former, the strain tending to sever *these* strips is twice as great in the former case. The corrugated metal is thus of a strength exactly adapted to the demands of the boiler, possessing great strength only in the direction where it is required.

The process of corrugating tends immediately to expose any latent imperfection in the iron, so that none but perfectly sound plates need ever be used. With this advantage, and with the increase of effective strength due to this mode of construction, it is considered practicable to construct larger shells and flues—a desideratum of importance, particularly upon the western waters.

We persist, however, in considering that the single feature of increased heating surface, and the freedom from scale, which has so far been obtained on these corrugated surfaces, are the principal features of the improvement—sufficient of themselves to make it one of the most important inventions of the day. The corrugated flue presents some 50 per cent. more fire surface in the same size and length, and, as we have before seen, it is a materially *better* surface. Its introduction, therefore, allows the choice of two advantages. Our present large boilers may be used with less fuel, by more thoroughly absorbing the heat of the fire, or a boiler, 33 per cent. less in length may be employed in their stead. The choice of these advantages may depend on the circumstances in any case.

The advantages claimed and established as belonging to the corrugated boiler may be condensed as follows:—

1. Increase of and improvement in the *heating* surface, and consequent economy of fuel, or otherwise the obtaining of the same effect from smaller, cheaper, and lighter boilers.
2. Diminished cost in consequence of absence of stays, and facility of repair due to the same cause.
3. Freedom from scale, in consequence of the bellows-like working of the corrugations, when exposed to changes of temperature or of pressure.
4. Durability, due to the absence of scale, and of the many stays and the like lodging-places for the same.
5. Increased stiffness or strength, and
6. Detection of any defects in the iron, which are sure to become apparent in the manufacture.

[From the Canadian Journal.]

Robert Stephenson, M. P.

The subject of this notice was born at Wilmington, near Newcastle-upon-Tyne, and is the son of the late George Stephenson, of Tapton House, near Chesterfield, in Derbyshire, who from the humblest origin rose to an eminence to which the vast benefits he has conferred on the world justly entitled him. The early life of the elder Stephenson affords a singular contrast to his subsequent history. Born in the village of Wylam, on the banks of the Tyne, near Newcastle; the son of a colliery workman, he had early to labor for a share of the household bread. From picking bats and dross from coal heaps, at twopence per day,—when so young that he used to hide when the overseer was passing, lest he should be thought too small to earn his wages,—he became a breakman on a tram road, and then a stoker to an engine on the estate of Lord Ravensworth, thankful for the advancement of his wages from one to two shillings per day. Here some repairs required by the engine afforded him an opportunity of displaying that native ingenuity of which he possessed so vast a fund. At this time the dearness of food and the lowness of wages pressed heavily upon him, but his energy triumphed, and as his prospects improved, he gave up the thoughts of emigration to the New World, which he had seriously entertained, and married at the age of twenty-two. On the 16th of November, 1803, his only son Robert was born. Meanwhile his natural powers of invention and the resources of his mind continued to develope themselves in various ways, so much so, that he early attained a local celebrity, and Lord Ravensworth and other of the Killingworth owners, had sufficient confidence in his ability to advance him sufficient means to build a locomotive, which was first tried on a tramway in 1814. His subsequent success is well portrayed in the following extract from a speech delivered by him on the occasion of opening the Newcastle and Darlington Railway in June, 1844.

> "Lord Ravensworth & Co.," said he, "were the first parties who would intrust me with money to make a locomotive engine. That engine was made thirty-two years ago; I said to my friends that there was no limit to the speed of such an engine, provided the works could be made to stand. In this respect, great perfection has been reached, and in consequence, a very high velocity has been attained. In what has been done under my management, the merit is only in part my own. I have been most ably assisted and seconded by my son. In the early part of my career, and when he was a little boy, I saw how deficient I was in education, and made up my mind that he should not labor under the same defect, but that I would put him to a good school, and give him a liberal training. I was, however, but a poor man, and how do you think I managed? I betook myself to mending my neighbors' clocks and watches, at night, after my daily work was done; and thus I procured the means of educating my son. He became my assistant and my companion. He got an appointment as under-viewer, and at night we worked together at our engineering. I got leave to go to Killingworth, to lay down a railway at Hetton, and next to Darlington, and after that I went to Liverpool to plan a line to Manchester. I there pledged myself to attain a speed of ten miles per hour. I said I had no doubt the locomotive might be made to go much faster, but we had better be moderate at the beginning. The directors said I was quite right; for, if when I went to Parliament, I talked of going at a greater rate than ten miles an hour, I would put a cross on the road. It was not an easy task for me to keep the engine down to ten miles an hour—but it must be done, and I did my best. I had to place myself in that most unpleasant of all positions—the witness-box of a Parliamentary Committee. I could not find words to satisfy either the committee or myself: some one inquired if I were a foreigner, and another hinted that I was mad. I put up with every rebuff, and went on with my plans, determined not to be put down. Assistance gradually increased, improvements were made—and to-day, a train which started from London in the morning, has brought me in the afternoon to my native soil, and enabled me to take my place in this room, and see around me many faces which I have great pleasure in looking upon."

His connection with the Liverpool and Manchester Line, placed him in the front rank of the engineers of that day; he also became the proprietor of an extensive locomotive manufactory at Newcastle, and an extensive owner of collieries and iron works. His death took place in August, 1848.

We have seen, from his own narrative, that George Stephenson fully appreciated the advantages of education, and he has told us of his manly conflict and stern purpose to win the means wherewith to enable his son to receive that training of which he so much felt the necessity himself, and the value of which he felt above all price. At the age of ten, Robert was sent to the academy of John Bruce, of Newcastle, where he remained until about sixteen; he then for a short time received private lessons in mathematics from Mr. Riddell (afterwards head master of the Royal Naval School at Greenwich), and was subsequently apprenticed as a coal-viewer to Mr. Nicholas Wood, in which occupation he remained three years. The name of George Stehpenson was by this time rising into eminence as an engineer, and looking forward to better prospects for his son; he removed him from his underground apprenticeship, and in 1821 placed him in the University of Edinburgh, where he studied under Professor Leslie, Dr. Hope, and Professor Jamieson. His father, however, could afford him no more than one session; but during that period he evinced an extraordinary capacity for acquiring knowledge, and a just appreciation of its value. Incited by the early lessons inculcated by the precepts and examples of his father, and by the necessity that he should be early at the profession he was destined to live by, his diligence knew no pause—every hour was improved; and he was rewarded by a corresponding proficiency. At the age of nineteen he returned from Edinburgh, and entered upon a new field of study with his father, who had about that time established his steam-engine manufactory at Newcastle. Here the same diligence which had characterized his session at the university, induced such incessant application to the study of his profession, as to impair his health, and his father, urged by the medical attendant, consented to his son's acceptance of the charge of an expedition to explore the silver and gold mines of Venezuela, New Grenada and Colombia, which had been set on foot by Messrs. Herring, Graham, and others. He sailed on this expedition in 1824, and remained in Colombia about four years.

In 1828 he sailed from Carthagena, round Cape Horn, to New-York, whence he travelled through that State, and passing into Upper Canada, he visited this city, then known as "Little York," to which the prefix of "muddy" was, as Mr. Stephenson says, justly added. From Toronto he proceeded through the Lower Province, visited Montreal, and finally took ship at Quebec for England.

When he sailed on his Colombia expedition, the "Surrey Iron Railway," first chartered in 1801, and again in 1808, connecting the quarries at Merstham and Reigate with Croydon and the Thames, at Wandsworth, a length of 21 miles, was the only public "Iron Road" in England; with this exception, the railways of England were private ones, and its commercial success was not such as to encourage the extension of similar speculations. Many private tramways from coal, iron, and other mines were, however, in existence, and on these some progress had been made in the construction of locomotives.

Locomotion by steam on common roads had been vaguely suggested by Watt, in 1759, and practically realized on a small scale, by Murdoch, in 1784. The idea of applying steam to the propulsion of wheeled carriages did not, therefore, originate with Richard Trevithick; yet it is to him we are indebted for its first application in a useful form, acting solely by its expansive force. His first engine was tried on the Myrthir Tydvil tram road, in 1804, with good success, drawing ten tons of useful load at the rate of five miles per hour. Trevithick's engine had but one cylinder, and was but ill adapted to maintain an equal continuous motion; the adhesion of the driving wheels to the rails was found to be variable, and these difficulties caused him to suggest auxiliary means of propulsion, the presumed necessity for which induced the contrivance and patenting of many expedients, some of them sufficiently ridiculous, and others remarkable only for their intricacy.

Passing over the continuous rack and wheel of Blenkinsop, the notable chains and drums of the brothers Chapman, and the automaton legs of Brunton, we find Mr. Blackett, of the Wyland Railway, recurring to the adhesion of the wheels to the rails, which he found sufficient when the weight of the engine was properly distributed. To make available the full power of his engines, he used two cylinders, with the cranks placed at right angles, and thus rendered his engines capable of producing an equal, continuous motion—this was in 1813. In 1814, the elder Stephenson constructed his first locomotive, in which and in his subsequent ones, he introduced several improvements, which gave his engines a superiority over those made by his contemporaries.

Although Mr. Blackett, as we have said, applied double cylinders to produce a continuous motion, his mode of attachment and of connecting the wheels was defective;—the wheels were connected by endless chains. These, however, were sufficient to establish the sufficiency of the *bite* of the wheels to draw the requisite number of loaded cars, and, therefore, general attention was redirected to improving the means of applying the power of the steam to the wheels. George Stephenson first introduced an ingenious arrangement of gearing to effect the desired end. His first engine, when tried up an incline of 1 in 450, dragged eight loaded wagons, weighing 30 tons, at the rate of about four miles per hour. In practice, however, it was found that the spur gearing caused considerable noise and jarring, which increased with the wear. To remedy this, Mr. Stephenson, in connection with Mr. Dodds, patented, in 1814, a method of attaching the connecting-rods of the engines to crank-pins in the arms of the driving-wheels, and used endless chains to keep the crank-pins at right angles with each other; for these chains outside connecting-rods were substituted; and, except that Nicholas Wood added wrought-iron tires to the driving-wheels, the locomotive remained for many years in the condition to which Stephenson had brought it.

We have thus briefly noticed the progress of locomotives, in order to show the state of utility to which they had been brought when Robert Stephenson returned to England, in 1828. When he departed for America, in 1824, there were very few locomotives in existence, and during his absence, no very important improvements had been made, except that Hackworth, of the Stockton and Darlington Railway, had introduced the blast-pipe (as it had been formerly applied by Trevithick) into an engine constructed for that line, which had six coupled wheels, and was capable of drawing a gross load of 100 tons, on a level, at the rate of five miles per hour.

During the same period, however, a new era had commenced in the history of railways. They had received an impetus from the increasing success of the locomotive. The Stratford and Moreton Line had been opened for the carriage of goods and passengers—the Stockton and Darlington was opened soon after; and, notwithstanding the commercial panic, and the difficulties which had to be overcome in Parliament, the Liverpool and Manchester Line was commenced, in 1826, under the unconquerable energies of the elder Stephenson, and his assistant, Mr. Joseph Locke. Mr. Nicholas Wood had also published his well-known "Practical Treatise on Railroads," in 1825; and, in that year of the wildest speculations, the idea of iron highways and rapid travelling by steam first seized upon the public mind. On the return of Stephenson to England, in 1828, he found the Liverpool and Manchester Railway rapidly approaching completion, and a general desire on the part of the public for a higher rate of speed than had yet been attained. The Directors of the Liverpool and Manchester Railway, in consequence of this feeling, and of the non-existence at that time of locomotives capable of meeting the public requirements, seriously contemplated working their road by stationary engines. Previous, however, to deciding this important question, a commission consisting of Messrs. George Stephenson, Locke, Walker, and Rastrick, was appointed, to collect information from the managers of the few railways and tram roads then in existence, as to the best power that could be applied, and more particularly as to the comparative merits of fixed and locomotive power. The result of their report showed a proportion of seven to nine[*] in favor of stationary power.

As, however, it was admitted that several improvements were being made in locomotives, the directors, influenced by the opinions of their engineer, and by the careful reasonings of a pamphlet, the joint production of Robert Stephenson and Joseph Locke, determined, at the suggestion of Mr. Harrison, one of their number, to offer a premium of £500 for the best locomotive which would conform to certain conditions, namely—it must consume its own smoke;—the whole weight of the engine and boiler must be carried on springs;—it must not exceed six tons in weight;—if of that weight, it must be able to draw a train of twenty tons, including the tender, at the rate of ten miles an hour on a level railway;—if of greater than four and a half tons weight, it must have six wheels. The conditions also announced that an engine of less weight would be preferred, if it performed an equal amount of work.

The local growth of railways, and the sudden impulse given to them in 1825, together with the several patents held by George Stephenson, in connection with locomotives, had been the means of causing his steam-engine manufactory, at Newcastle, to become exclusively a locomotive manufactory; and to it, during a space of three years after his return from America, Robert Stephenson devoted the greater part of his time—having charge, however, during the same period, of the construction of the Warrington and Newton and of the Leicester and Swamington Railways. During this period, as we have seen, the nature of the power to be used on the Liverpool and Manchester Line had to be determined; and Robert Stephenson at once entered into the competition, resolving to outstrip the conditions imposed upon the competitors.

To be continued.

Evaporation of Water in Steam Boilers.

[From D. K. Clark's Work on Railway Machinery.]

Recapitulation.—The quantity or weight of water evaporable per hour, at a given rate of combustion, increases with the temperature at which the water is pumped into the boiler.

2. Consequently, the equivalent weight of water evaporable from the standard temperature, 62°, decreases as the initial temperature of the water actually evaporated rises, at such a rate, that the equivalent weights fall 1 per cent. for every 10° rise of initial temperature. At this rate only 85 per cent. of water evaporated from 212° would be evaporable from 62°.

3. The equivalent volumes of water evaporable from 62 also decrease as the initial temperature rises, but rather more slowly than the equivalent weights, inasmuch as water expands by heat; 88 per cent. of water evaporated at 212° would be evaporable at 62.°

4. The evaporative efficiency of locomotives depends very much on the management of the fire. Low fires, in general, evaporate more water than deep fires, as there is less coke exposed to waste; the proper use of the ash-pan damper also promotes the economy of combustion, by regulating the draft to the requirements of the time.

5. A poundage of water, equal to 9 lbs. per pound of coke, is adopted as the standard of economical consumption in practice.

6. The rate of evaporation per pound of fuel, or the poundage of water, is regulated by the area of the fire grate, the extent of heating surface, and the rate of consumption per hour. In general, the smaller the fire grate, the greater the heating surface; and the less the consumption per hour, within certain limits, the greater is the poundage of water.

Conversely, the poundage of water falls nearly as the rate of evaporation is increased above the economic line, involving a reduced efficiency, and a heavy sacrifice of fuel.

7. The maximum economical hourly consumption increases directly as the grate area is reduced, even with the same heating surface; showing that the economic value of heating surface is increased by reducing the grate, and that by this simple expedient, the same heating surface can economically evaporate larger quantities of water per hour.

8. The economical hourly consumption increases directly as the square of the heating surface, with the same grate; so that twice the surface would yield four times the consumption; showing that

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[*] Seven to two is doubtless intended.

the economic value of each foot of surface is increased by merely increasing the surface.

9. The necessary heating surface increases only as the square foot of the consumption, the grate being the same.

10. The necessary heating surface increases as the square foot of the grate, the consumption being the same.

11. As the economic value of heating surface depends so much on the grate area being less as the area is greater, the grate should be kept as small as is consistent with the demands for steam, and the practicable rate of combustion. On the other hand, there can be no economical objection to any amount of heating surface which can be got into a boiler, even though greater than the economic limits. Thus there are two ways of meeting defective proportions, by increasing the heating surface, or by reducing the grate, either of which increases the economic value of the heating surface—in other words, the economic evaporative power of the boiler.

12. The relations of grate area, heating surface, and economical consumption are such, that

With heating surfaces,	30,	60,	90,	100	times the grate,
The maximum economical consumptions are	2,	8,	18,	22	cubic feet of water per hour per foot of grate,
and	14,	55·6,	125,	153	pounds of coke.

13. The amount of clearance between the tubes affects the evaporative efficiency of the tube surface; and it ought to be greater, the greater the number of tubes. For ordinary good practice, on which the foregoing conclusions are founded, clearance at the rate of ⅛ inch for every 30 tubes is sufficient; for example, ½ inch for 120 tubes, ⅝ inch for 150 tubes, and ¾ inch for 180 tubes.

14. The maximum rate of efficient combustion of good coke in the fire-box has been found in practice to be about 150 lbs. per hour per foot of grate; and of evaporation, about 22 cubic feet of water per hour per foot.

15. The minimum weight of combustion worth any thing for evaporation is probably about 14 lbs. per hour per foot of grate.

16. The maximum rate of combustion recommended for locomotive boilers is 112 lbs., or 1 cwt. of coke per hour per foot of grate, when the grate has at least 8 feet of surface; and of evaporation, 16 cubic feet of water per hour per foot.

17. These rates of consumption require a heating surface of 85 feet per foot of grate; and this is the lowest proportion that should be adopted for locomotive boilers.

18. A grate area of 4 feet is probably the smallest that should be adopted for railway purposes; and as the smallest grates require the greatest attention in firing, a consumption of about 76 lbs. of coke, and 11 feet of water per hour per foot of grate is the highest duty for which four feet grates should be designed; for large grates, the duty may be increased up to the standard for 8 feet grates.

19. The evaporative capacity of locomotive boilers appears, so far as experience goes, to be the same at all speeds.[*]

20. The economic evaporative value of coal is, according to ordinary practice, about two-thirds of that of coke. But as coal is not likely to come into more general use as fuel, and will continue to be used only as an auxiliary with coke, it is not necessary to reconsider the proportions of the locomotive boiler, with any view to the increased employment of that fuel.[†]

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Commercial Contests—Railroads against Rivers.

When the commerce of the world was water-borne, from the point of production to that of consumption, it was compelled to wind along the sinuosities of the river, and creep along the indentation of the coast. When a barrier, impassable to a direct inland communication, separated the lake shores and the Ohio valley from the Atlantic ports, and the corn or coal of Western Pennsylvania or Virginia pursued the Monongahela, the Mississippi, and the favoring currents of the Gulf, to their ultimate markets, then Pittsburgh was separated from Philadelphia by a water route almost double the length and more than quadruple the time of a transatlantic voyage. In those days, the port of New Orleans was as indispensable to the interior commerce as the Dardanelles to the Danube. The right of deportation was then deemed cause of war—the distinctness of sectional interests had been almost the means of disunion. Then New Orleans was a commercial city, rather to be maintained at any cost of men and capital, and that cost was to be levied upon the commerce of the interior. It was then that New Orleans was the Calcutta of the Union; gallant and energetic young men left the sterile States, to stake an early grave or a shattered constitution against a rapid fortune and a safe return. But all this has been changed by American enterprise.

Let us regard the States which lie between the Mississippi valley and the Atlantic as a long and comparative peninsula, the southern extreme of which is the Cape of Florida. All interior commerce was once compelled to wander around this natural and once impassable obstacle, upon the obvious axiom that the markets of the world are the magnetic poles to which production tends by the shortest, cheapest, and safest lines. American enterprise has established new means of promoting the connections between these elementary and ultimate processes of human industry. First lines of canals crossed the peninsular States; then steam—that boldest and most benevolent of radicals—employed the railroad, and now these iron rivers, without the obstacles of snags, currents, ice, or sand-bars, take their rise upon the basins of the Mississippi and the Lakes, and from their trade currents directly into the harbors of the Atlantic. Hence the contest between those cities which, like New Orleans and Mobile, rely upon their positions upon the natural streams, and those which, like Boston, New-York, Philadelphia, Baltimore, Charleston, and Savannah, rely entirely upon the artificial lines by which they are connected with the productive interior.

It is a fair competition between an untaxed transit upon the river and the ocean, and the artificial facilities devised by the skill of man. In this contest, the artificial system with its accessory advantages promises to prevail. All the provision trade of the North-west, destined for Eastern or European consumption, is adopting the lines of direct communication. They have the advantage of immediate participation in the market prices. They have thus the command of banking and other facilities, based upon the immediate convertibility of agricultural products into money; they have the advantage of a transit through a more temperate latitude. The artificial system possesses the additional advantage of unity in the administrations which conduct it. A railroad unites the proprietorship of the road with the exclusive transportation upon it. It may thus discriminate in favor of or against any specific interest necessary to sustain its trade. Thus, if a railroad wished to take trade or travel from a river, it would reduce its charges upon articles of competition, and assess them upon those which could best sustain them. But the artificial system possesses another powerful advantage. Each of the Atlantic cities will be proprietor of a complete system of public roads. If the competition of the water routes rendered it necessary, these roads would be worked at a loss, and that loss charged to account of city expenses, for it would be better to pay interest on a railroad to some extent unproductive, than to lose a trade indispensable to a city. Just as New Orleans keeps up a superior levee, which, although entirely unproductive, is indispensable to her trade. Such are the powers, such the necessities of the artificial system, that the very growth of the cities will compel the maintenance of existing or improved lines, since the cities must shrink and relapse with the withdrawal of the trade which has stimulated their more recent growth.

There is still another element of advantage in the artificial system; the Atlantic cities are competing with each other for the interior trade. Lines are made straight, grades are reduced, the roads are made shorter, cheaper, safer. We have recently had a specimen of the competition between these cities, in the arrangement of the Baltimore and Ohio Railroad, to reduce freights and fares upon the Philadelphia business passing over their lines. Indeed, the history of all these routes is but a narration of competition.

Now, unfortunately for those cities which depend, like New Orleans and Mobile, upon the natural current of trade, the competition amongst the several Atlantic cities is a joint competition against the former, and as these *crevasses* in the river trade become bolder and more decided, they will divert more and more of the great aggregate which has hitherto sought an outlet through the river cities and the Gulf of Mexico.

In addition to the reason given why this diversion of the current of trade is inevitable, we may add that the disadvantages of the Mississippi and coastwise navigation are irremediable. The loss by fires, wrecks, and climate, must continue to be represented by a positive charge upon commerce, and even the expense and risk of living in the river cities. The annual interruption of business by a climatic mortality, must affect the cost of factorage, and the facilities of business.

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[*] Assuming the efficiency of combustion to be the same, it might be deduced from previous discussions of the relations of evaporative power, blast pressure, vacuum in the smoke-box, and speed, that the maximum rate of evaporation should be the same for all speeds. This question will be duly considered when we have to construct a general theory of the locomotive from the materials supplied by experiment.

[†] The author is gratified to find from the later writings of Mr. Fairbairn, of Manchester, and Mr. Buchanan of Glasgow, that his views of the economy of combustion and evaporation harmonize with those of these authorities. Mr. Fairbairn has in his paper "On the Consumption of Fuel and the Prevention of Smoke" (1851), repeatedly recognized and set forth the value of a "*large heating surface as opposed to a small grate*," and the author is not sure but his formulas for economic proportions might apply to ordinary land or marine boilers. He feels certain, that at least the principles on which the formulas are based will be found to apply to other classes of boilers.

We therefore conclude, that the greater portion of the inferior trade, which has heretofore sought an outlet through the Gulf of Mexico, will, upon the completion of the system of artificial improvement, be exported direct through the various Atlantic seaport cities from Boston to Savannah, each taking that proportion of this trade to which its enterprise, its facilities, and its position shall entitle it. There will be enough for all, and in all their attributes, our own city will compare favorably with others.

But, although we regard this result as inevitable, we by no means consider that the depopulation or decline of New Orleans, and other river cities, will follow. It would be unfeeling to doom them to destruction, and coldly parcel out their commerce as an inheritance amongst ourselves. The immense and rapid development of the Southern States, the trade of Mexico, and the West India Islands, that of Central and of South America, with the demand which must always exist for the products of the Mississippi valley—the liberal system of interior communication, that the cities of New Orleans and Mobile have projected, will insure to them a valuable trade, and as the progress of American enterprise shall extend beyond its present influence, they will stand in the same relation to those sections south of their position, that the Atlantic cities now do to their northern customers. They will be upon the most direct line of communication between the South and Southwest, and the Eastern States and Europe. They will thus open not only markets for the factorage of southern staples, but will conduct their exchange for the merchandise and manufacture of more temperate climes. In a word, with that leading characteristic of the American people to adapt their energies to any emergency, we expect to see New Orleans enjoy a trade—changed it may be true in its character—but enlarged in its extent, and more valuable in its nature.

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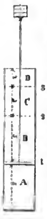
Expansive Force of Steam and other Elastic Fluids.

The expansive force of steam is now extensively employed, and greatly contributes to the economy of the modern steam engine. It is usual to estimate this force by the laws of air, as defined by Boyle and Mariotte. These laws are simple, and are thus explained by John Sewell, whose remarks on the subject we have carefully revised for our columns:—

The pressure or force of a confined elastic body is in the ratio of the space in which it is confined, hence the contents of any given space containing an elastic fluid, multiplied by the pressure of that fluid, will be a constant quantity of force, and its pressure in any other space will be that constant quantity, divided by the contents of the space into which the fluid has entered; or its force is inversely as its space.

Fig. 1.



For example, let the fig. No. 1 represent a cylinder 15 inches long and 1 square inch area, fitted with a piston P, and the part A, 5 inches long, filled with steam or air of 15 lbs. pressure, and the space B C D a vacuum. Now, if the weight or resistance, on the piston-rod, balance the 15 lbs., the piston will be stationary at 1; but if a weight of 7·5 lbs. is removed, the balance will be destroyed, and the piston ascend by the expanding force of the confined steam or air in A, until a balance of pressure again takes place. Suppose this is at 2, the piston will have moved 5 inches, and the steam or air will occupy double the space it did in A, with only half its original pressure, for the original pressure 15 × 5 inches space = 75 for the constant quantity, and 75 ÷ by the space A B = 10 inches, gives 7·5 lbs. as the expansive force in A B.

If another weight is removed of 1·73 lbs., the expanding air or steam will again raise the piston as before; and if it become stationary at 3, the space A B C will be equal to 13, and the constant quantity 75 ÷ 13 = 5·77 lbs. is the pressure exerted in the space A B C. If the last weight is removed, the expanding air will raise the piston to the top, and occupy a space of 15 inches, or three times its original space, still giving out a force = 75 ÷ 15 = 5 lbs. per square inch.

These results may be thus stated:—

The space A B : the space A :: the force in A : the pressure A B;
for 10 : 5 :: 15 : 7·5, the pressure in A B = 1st expansion.
The space A B C : the space A B :: the force in A : the pressure A B C;
for 13 : 5 :: 15 : 5·77, the pressure in A B C = 2d expansion.
The space A B C D : the space A B C :: the force in A : the force in A B C D;
for 15 : 5 :: 15 : 5, the pressure in A B C D = 3d expansion.

Compression is the converse of expansion, and the pressure would be in the ratio of the compressing force.

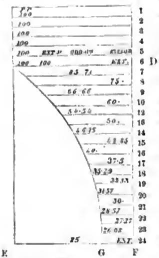
Thus, to compress the air into its original space of 5 inches again, we have 15 × 5 = 75 as the constant quantity, and

75 ÷ 13 = 5·77 lbs. = 1st compressing force.
75 ÷ 10 = 7·5 lbs. = 2d compressing force.
75 ÷ 5 = 15· lbs. = 3d compressing force.

This example of elasticity will show that the pressure or force in the original space, is to the force in the other spaces, as the contents of each of these spaces are to the contents of the original space, and explains the general law of air, as applied to ordinary steam.

The theoretical line C G, which diagrametically represents the ratio of expanding pressure, is found to be a hyperbolic curve, as shown in Fig. No. 2, which represents a cylinder of 12 sq. inches area, and 24 inches long, divided into 24 equal parts.

Fig. 2.



Full press. = 600
Extreme press. = 125
Odd ordinate press. = 414.57
Even " " = 355·95

Ex. Let each line of division, 1, 2, 3, 4, &c., represent the position of a piston impelled by air or steam, having a pressure of 100 lbs. per square inch, and cut-off at one quarter stroke; required, the mean pressure throughout the stroke, the mean pressure throughout the expansive portion of the stroke, and the pressure at each separate ordinate of division during the expansive action.

The rectangular part of full pressure A B C D × by the hyperbolic logarithm of the ratio (4) of expansion being = to the area of the rectangular hyperbola C D G F, we have for the mean pressure throughout the stroke, as follows:—

Hyp. log. of 4 = 1·386 × 6 (full pressure part) = 8·316, as the area of the space C D E F, which multiplied by the pressure 100 = 831·6, and ÷ 18 (the number of the spaces) = 46·2 lbs. per square inch as the mean pressure of expansion; and throughout the cylinder the full pressure = 6 parts × 100 (pressure) = 600 + 831·6(expansive pressure) = 1431·6 ÷ 24 spaces = 59·65 lbs., as the mean pressure throughout the stroke.

The mean pressure throughout the cylinder may be found more readily by considering the full pressure part as 1, or the unit of the ratio of expansion, and adding it to the hyp. log. of the ratio. This sum, multiplied by the pressure and divided by the ratio of expansion, will give the mean pressure. Thus, hyp. log. of 4 = 1·386 + 1 = 2·386 × 100 ÷ 4 = 59·65 lbs., as before.

If, instead of multiplying by the pressure and dividing by the ratio of expansion, the sum 2·386 is multiplied by the extreme pressure of 25 lbs. or 100 ÷ 4 = 25, it is obvious that the result will be the same.

Table No. 2 contains Napierian (often called hyperbolic) logarithms for calculating expansive steam power, as in this example. —See page 273.

The base of the Napierian logarithms, still used in the highest branches of mathematical analysis, is 2·71828, whose asymptotes are at right angles to each other; but the base of the Briggean logarithms, used in all ordinary calculations, is 10, whose asymptotes make an angle of 25·7404° to each other.

For the pressure at each ordinate of expansion: By the law of expansion, we have 6 × 100 for the constant quantity expanding to fill from 6 to 24 successively increasing spaces, hence—

Full pressure 6 spaces × 100 ÷ 6 = 100 lbs. mean pressure, and for expansion,

As 7	spaces	: 6	spaces	:: 100 lbs.	pres.	: 85·71 lbs.	pres. at	1st	exp. ord.
8	"	: 6	"	:: 100 lbs.	"	: 75·	"	2d	"
9	"	: 6	"	:: 100 lbs.	"	: 66·66	"	3d	"
10	"	: 6	"	:: 100 lbs.	"	: 60·	"	4th	"
11	"	: 6	"	:: 100 lbs.	"	: 54·54	"	5th	"
12	"	: 6	"	:: 100 lbs.	"	: 50·	"	6th	"
13	"	: 6	"	:: 100 lbs.	"	: 46·15	"	7th	"
14	"	: 6	"	:: 100 lbs.	"	: 42·85	"	8th	"
15	"	: 6	"	:: 100 lbs.	"	: 40·	"	9th	"
16	"	: 6	"	:: 100 lbs.	"	: 37·5	"	10th	"
17	"	: 6	"	:: 100 lbs.	"	: 35·29	"	11th	"
18	"	: 6	"	:: 100 lbs.	"	: 33·33	"	12th	"
19	"	: 6	"	:: 100 lbs.	"	: 31·57	"	13th	"
20	"	: 6	"	:: 100 lbs.	"	: 30·	"	14th	"
21	"	: 6	"	:: 100 lbs.	"	: 28·57	"	15th	"
22	"	: 6	"	:: 100 lbs.	"	: 27·27	"	16th	"
23	"	: 6	"	:: 100 lbs.	"	: 26·08	"	17th	"
24	"	: 6	"	:: 100 lbs.	"	: 25·	"	18th	"

Exp. 18 spaces and 795·52 ÷ 18 = 44·2 lbs. as the arithmetical mean of expansive pressure.

These values give the pressure at each separate line of expansion, yet the arithmetical mean only represents the mean of rectangular spaces, but does not include the curved portion at the end of each rectangle, and gives a mean 2 lbs. less than the real mean found by hyp. logarithms. The full pressure being the same in both cases, the mean difference is less than the expansive difference, for 600 + 795·52 ÷ 24 = 58·15 lbs. as the mean arithmetical pressure throughout the cylinder, or 1·50 lb. less than the real mean.

The contrary would take place with compressed steam, as each rectangle would contain a space beyond the curved line, and thus give the pressure in excess. A near approximation is obtained by adding together the two extreme pressures; 4 times the sum of the *even* ordinates (6, 10, 12, &c.), and twice the sum of the *odd* ordinates (7, 6, 11, &c.). This sum, multiplied by the common distance, and divided by 3, gives the force of expansion nearly; thus referring to the diagram, No. 50.

The extreme pressures = 100· + 25 = 125·
The even ordinates = 355·95 × 4 = 1423·8
The odd ordinates = 414·57 × 2 = 829·14

$$\frac{2377{\cdot}94}{3} = 792{\cdot}65 \text{ lbs.}$$

as the amount of the expansive pressure, and $\frac{792{\cdot}65 + 600}{24} =$ 58·32 lbs., or 1·33 less than by hyp. logarithms.

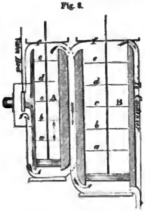
A summary of these methods of calculation will show their comparative approximation.

Hyperbolic method = 59·65 lbs.
Ordinate " = 58·32 "
Arithmetical " = 58·14 "

Either method may therefore be used, according to the degree of accuracy required, for with working steam, the effect of losing temperature, or of condensation, would cause the result to be less than the hyperbolic mean.

Double Cylinder Expansion.

Fig. 3.



This plan of working stationary engines with high-pressure steam in a small cylinder, and then expanding it to work another piston in a larger cylinder communicating with a condenser, is now found to be a very useful one.

It is on this plan that Mr. Adams proposes his cylinders for locomotive engines.

Let fig. No. 3 represent two such cylinders, of which the smaller, A, is 6 cubic feet in capacity, and the larger, B, of 24 cubic feet capacity, or in the ratio of 1 to 4. The first cylinder, A, receives the steam, say of 40 lbs. pressure per square inch from the boiler, and the second cylinder, B, receives the steam, as indicated by the respective arrows, from the cylinder A, after it has done its duty in that cylinder. Now, as the area of the larger cylinder is 4 times that of the smaller one, it follows that the steam expands to four times its volume in the larger cylinder, with a power corresponding to the diminution of force, and whilst the communication between the two cylinders is open, there is the same pressure in both cylinders, consequently the effective pressure in the larger cylinder is only on the three-fourths of its area, which it exceeds the smaller one.

As has been seen, the pressure of elastic fluids is inversely as the space they occupy; if we suppose these cylinders divided into, say six equal parts, 1, 2, 3, 4, 5, 6, it will sufficiently illustrate the comparative force of two cylinders.

For a constant quantity we have the capacity of the smaller cylinder, as 6 cubic feet, to be expanded into 24 cubic feet, and also fill the passages, say 6-10 of a foot, between the cylinders. If the pistons be moved through 1-6th of their stroke to *a a*, the pressure would be as under:

IN SMALL CYLINDER.					IN LARGE CYLINDER.				
Full Press. c. ft.		Empty Space. c. ft.		Space still filled. c. ft.	Space filled. c. ft.		Passages. c. ft.		Steam expanded to fill. c. ft.
6	—	0	=	6	+ 0	+	·0	=	6· initial
6	—	1	=	5	+ 4	+	·6	=	9·6 for *a a*
6	—	2	=	4	+ 8	+	·6	=	12·6 for *b b*
6	—	3	=	3	+ 12	+	·6	=	15·6 for *c c*
6	—	4	=	2	+ 16	+	·6	=	18·6 for *d d*
6	—	5	=	1	+ 20	+	·6	=	21·6 for *e e*
6	—	6	=	0	+ 24	+	·6	=	24·6 for *f f*

Taking the force of steam as 40 lbs. per square inch, the pressures for the respective ordinates of expansion, in double and single cylinder engines, would then be inversely—

	Expand. Space.	lbs.	Orig. Space.	In dble. Cylin. lbs.	Expanded Space.	In Single Cylin. lbs.
Initial in first cylinder.	6	: 40	:: 6	: 40·	none	40
Initial in second cylin.,	6·6	: 40	:: 6	: 36·36	between the pistons	none
First space of expan.,	9·6	: 40	:: 6	: 25·	ditto, or *a a*	26·26
Second "	12·6	: 40	:: 6	: 19·04	ditto, or *b b*	20·
Third "	15·6	: 40	:: 6	: 15·38	ditto, or *c c*	16·
Fourth "	18·6	: 40	:: 6	: 12·36	ditto, or *d d*	13·33
Fifth "	21·6	: 40	:: 6	: 11·11	ditto, or *e e*	11·42
Sixth "	24·6	: 40	:: 6	: 9·75	ditto, or *f f*	10·

The mean pressure may be found by the rules already submitted. For the large cylinder by hyp. log. it will be

Exponent of expansion = 24·6 ÷ 6 = 4·1, whose log. = 1·411 × 36·36 × 6·6 ÷ 18·6 (spaces to fill) = 18·2 lbs., nearly as the mean pressure throughout the stroke on the large piston. On the smaller piston it would be 40—18·2 (the pressure on the larger piston) = 21·8 lbs., hence taking the value of the vacuum in the condenser as = to 12 lbs., for the power exerted we have the

$$\left.\begin{array}{lcl} \text{Small cylinder area} & = & 6 \times 21{\cdot}8 = 120{\cdot}8 \\ \text{Large cylinder area} & = & 24 \times 18{\cdot}3 = 436{\cdot}8 \\ \text{Condenser vacuum} & = & 24 \times 12{\cdot}0 = 288 \end{array}\right\} \begin{array}{l} \div 24 = 35{\cdot}23 \\ \text{lbs mean.} \\ \text{pressure.} \end{array}$$

Total power . . = 845·6

Out of this 845·6 lbs. of accumulated power, 288 lbs., or one-third of the whole, is due to the vacuum in the condenser, and 557·6 or two-thirds to the steam.

It may be instructive to compare the power given out in a single cylinder of the same capacity, and using the same quantity of steam. Thus, Nap. log. of 4·1 = 1·411 × 40 × 6 ÷ 18·6 = 17·67 lbs. as the mean pressure of expansion.

And as before—

$$\left.\begin{array}{lcl} \text{Full pressure area} & = & 6 \times 40 = 240{\cdot}00 \\ \text{Expended press. area} & = & 18{\cdot}6 \times 17{\cdot}67 = 328{\cdot}66 \\ \text{Condenser vacuum} & = & 24{\cdot}6 \times 12{\cdot}0 = 295{\cdot}20 \end{array}\right\} \begin{array}{l} \div 24 = 35{\cdot}99 \\ \text{lbs. mean} \\ \text{pressure.} \end{array}$$

Total power . . = 863·86

Now 863·86 — 845·6 = 18·26 lbs., or 2·16 per cent. in favor of the power given out on one cylinder; but with this greater power there is also much greater irregularity of motion. For various classes of machinery now driven by steam such irregular motion would be highly detrimental, whilst the more uniform motion produced by the double-cylinder engine enables the principle of expansion to be more extensively applied to general purposes than by the single-cylinder engine.

There are other modifications of the double or combined cylinder engine, where the cylinders are placed on the top of each other, and differently arranged to provide the utmost economy; but the diagram conveys the idea of their action more clearly than if mechanically correct in the arrangement of the steam passages or position of the cylinders. They are a valuable class of engines.

Table No. 1 contains the relative properties of unexpanded steam of different temperatures and in various definitions.

Table No. 1.

Temperature, Pressure, and relative Volume of Steam from 212° to 387·3° Fahr. in English and French Measures.

Pressure on a Square inch, including the Pressure of the Atmosphere.		Elastic Force in		Temperature in Degrees of			Volume of Steam compared with the Volume of Water.	Power of 1 cub. foot of Water as Steam in lbs. raised 1 ft. high.
		Inches of Mercury.	Metres of Mercury.	Fahr.	Reaum.	Cent.		
lbs.	kilog.	in.	metres.	deg.	deg.	deg.	litres.	lbs.
14.7	6·668	30·00	·762	212·0	80·0	100·0	1700	2033
15	6·80	30·60	·778	212·8	80·4	100·4	1669	2066
16	7·26	32·64	·829	216·3	81·9	102·4	1573	2087
17	7·71	34·68	·880	219·6	83·3	104·2	1488	2107
18	8·16	36·72	·932	222·7	84·7	105·9	1411	2117
19	8·62	38·76	·984	225·6	86·0	107·6	1343	2126
20	9·07	40·80	1·037	228·5	87·3	109·2	1281	2135
21	9·52	42·84	1·089	231·2	88·5	110·7	1225	2144
22	9·98	44·88	1·140	233·8	89·7	112·1	1174	2152
23	10·43	46·92	1·192	236·3	90·8	113·5	1127	2160
24	10·88	48·96	1·244	238·7	91·9	114·8	1081	2168
25	11·34	51·00	1·296	241·0	92·9	116·1	1044	2175
26	11·79	53·04	1·348	243·3	93·9	117·4	1007	2182
27	12·25	55·08	1·400	245·5	94·9	118·6	973	2189
28	12·70	57·12	1·452	247·6	95·8	119·8	941	2196
29	13·15	59·16	1·503	249·6	96·7	120·9	911	2202
30	13·61	61·21	1·555	251·6	97·6	122·0	883	2209
31	14·06	63·24	1·607	253·6	98·5	123·1	857	2215
32	14·51	65·28	1·659	255·5	99·3	124·2	833	2221
33	14·97	67·32	1·711	257·3	100·1	125·2	810	2226
34	15·42	69·36	1·763	259·1	100·9	126·2	788	2232
35	15·87	71·40	1·814	260·9	101·7	127·2	767	2238
36	16·33	73·44	1·866	262·6	102·5	128·1	748	2243
37	16·78	75·48	1·918	264·3	103·2	129·1	729	2248
38	17·23	77·52	1·970	265·9	104·0	129·9	712	2253
39	17·69	79·56	2·022	267·5	104·7	130·8	695	2259
40	18·14	81·60	2·074	269·1	105·4	131·7	679	2264
41	18·59	83·64	2·126	270·6	106·0	132·6	664	2268
42	19·05	85·68	2·178	272·1	106·7	133·4	649	2273
43	19·50	87·72	2·229	273·6	107·4	134·2	635	2278
44	19·96	89·76	2·281	275·0	108·0	135·0	622	2282
45	20·41	91·80	2·333	276·4	108·6	135·8	610	2287
46	20·86	93·84	2·385	277·8	109·2	136·6	598	2291
47	21·32	95·88	2·437	279·2	109·9	137·3	586	2296
48	21·77	97·92	2·489	280·5	110·4	138·1	575	2300
49	22·22	99·96	2·541	281·8	111·0	138·8	564	2304
50	22·68	102·00	2·592	283·2	111·6	139·6	554	2308
51	23·13	104·04	2·644	284·4	112·2	140·2	544	2312
52	23·59	106·08	2·696	285·7	112·8	140·9	534	2316
53	24·04	108·12	2·748	286·9	113·3	141·6	525	2320
54	24·49	110·16	2·800	288·1	113·8	142·3	516	2324
55	24·95	112·20	2·852	289·3	114·4	142·9	508	2327
56	25·40	114·24	2·903	290·5	114·9	143·6	500	2331
57	25·85	116·28	2·955	291·7	115·4	144·3	492	2335
58	26·31	118·32	3·007	292·9	116·0	144·9	484	2339
59	26·76	120·36	3·059	294·2	116·5	145·7	477	2343
60	27·21	122·40	3·111	295·6	117·2	146·4	470	2347
61	27·67	124·44	3·163	296·9	117·7	147·2	463	2351
62	28·12	126·48	3·215	298·1	118·3	147·8	456	2355
63	28·57	128·52	3·266	299·2	118·8	148·4	449	2359
64	29·03	130·56	3·318	300·3	119·2	149·1	443	2362
65	29·48	132·60	3·370	301·3	119·7	149·6	437	2365
66	29·93	134·64	3·422	302·4	120·2	150·2	431	2369
67	30·39	136·68	3·474	303·4	120·6	150·8	425	2372
68	30·84	138·72	3·526	304·4	121·1	151·3	419	2375
69	31·29	140·76	3·577	305·4	121·5	151·9	414	2378
70	31·75	142·80	3·629	306·4	122·0	152·4	408	2382
71	32·20	144·84	3·681	307·4	122·4	153·0	403	2385
72	32·66	146·88	3·733	308·4	122·8	153·6	398	2388
73	33·11	148·92	3·785	309·3	123·2	154·1	393	2391
74	33·56	150·96	3·837	310·3	123·7	154·6	388	2394
75	34·02	153·02	3·889	311·2	124·1	155·1	383	2397
76	34·47	155·06	3·940	312·2	124·5	155·7	379	2400
77	34·93	157·10	3·992	313·1	124·9	156·2	374	2403
78	35·38	159·11	4·044	314·0	125·3	156·7	370	2405
79	35·83	161·18	4·096	314·9	125·7	157·2	366	2408
80	36·29	163·22	4·148	315·8	126·1	157·7	362	2411
81	36·74	165·26	4·199	316·7	126·5	158·2	358	2414
82	37·19	167·30	4·250	317·6	126·9	158·7	354	2417
83	37·65	169·34	4·303	318·4	127·3	159·1	350	2419
84	38·10	171·38	4·355	319·3	127·7	159·6	346	2422
85	38·55	173·42	4·407	320·1	128·0	160·1	342	2425
86	39·01	175·46	4·459	321·0	128·4	160·6	339	2427
87	39·46	177·50	4·511	321·8	128·8	161·0	335	2430
88	39·91	179·54	4·563	322·6	129·2	161·4	332	2432
89	40·37	181·58	4·615	323·5	129·6	161·9	328	2435
90	40·82	183·62	4·666	324·3	129·9	162·4	325	2438
91	41·27	185·66	4·718	325·1	130·3	162·8	322	2440
92	41·73	187·70	4·770	325·9	130·6	163·3	319	2443
93	42·18	189·74	4·822	326·7	131·0	163·7	316	2445
94	42·64	191·78	4·874	327·5	131·3	164·2	313	2448
95	43·09	193·82	4·926	328·2	131·6	164·6	310	2450
96	43·54	195·86	4·977	329·0	132·0	165·0	307	2453
97	44·00	197·90	5·029	329·8	132·4	165·4	304	2455
98	44·45	199·92	5·081	330·5	132·7	165·8	301	2457
99	44·90	201·96	5·133	331·3	133·0	166·3	298	2460
100	45·36	204·01	5·185	332·0	133·3	166·7	295	2462
110	49·89	224·40	5·703	339·2	136·5	170·7	271	2486
120	54·43	244·82	6·222	345·8	139·5	174·3	251	2507
130	58·97	265·23	6·740	352·1	142·3	177·8	233	2527
140	63·50	285·61	7·259	357·9	144·8	181·1	215	2545
150	68·04	306·03	7·778	363·4	147·3	184·1	205	2561
160	72·57	326·43	8·296	368·7	149·6	187·1	193	2577
170	77·11	346·80	8·814	373·6	151·8	189·8	183	2593
180	81·65	367·25	9·333	378·4	153·9	192·4	174	2608
190	86·18	387·61	9·851	382·9	155·9	194·9	166	2622
200	90·72	408·04	10·370	387·3	157·9	197·4	158	2636
210	95·23	428·42	10·88	391·3	159·7	199·6	151	2650
220	99·77	448·82	11·39	395·5	161·2	201·9	145	2663
230	104·3	469·23	11·91	399·4	163·3	204·1	140	2675
240	108·8	489·62	12·43	403·1	164·9	206·1	134	2688

The relative weight of steam to water is nearly as their relative volumes. Thus, in Table No. 1, the relative volume of steam of atmospheric pressure is given as 1700, therefore the weight of a cubic foot of steam is 1-1700th part of a cubic foot of water. For a cubic foot of water = 62·32 lbs. × 7000 grains troy each lb., so that 436,240 grains ÷ by 1700 = 256·7 grains; and for other pressures use the ratio of the volume for a divisor.

Inches of mercury × ·4919 = lb. avoirdupois, and lb. av. × 2·03294 = inches of mercury.

Table No. 3 contains the arithmetical pressures, means and ratios of a power of 1, expanded 24 times and at 24 different ordinates of any stroke, illustrated by diagram, No. 2.

Table No. 2.

Napierian or Hyperbolic Logarithms.

Num.	Nap. Log.	Num.	Nap. Log.	Num.	Nap. Log.	Num.	Nap. Log.	Num.	Nap. Log.
1·05	·049	3·05	1·115	5·05	1·619	7·05	1·953	9·05	2·203
1·1	·095	3·1	1·131	5·1	1·629	7·1	1·960	9·1	2·208
1·15	·140	3·15	1·147	5·15	1·639	7·15	1·967	9·15	2·214
1·2	·182	3·2	1·163	5·2	1·649	7·2	1·974	9·2	2·219
1·25	·223	3·25	1·179	5·25	1·658	7·25	1·981	9·25	2·225
1·3	·262	3·3	1·194	5·3	1·668	7·3	1·988	9·3	2·230
1·35	·300	3·35	1·209	5·35	1·677	7·35	1·995	9·35	2·235
1·4	·336	3·4	1·224	5·4	1·686	7·4	2·001	9·4	2·241
1·45	·372	3·45	1·238	5·45	1·696	7·45	2·008	9·45	2·246
1·5	·405	3·5	1·253	5·5	1·705	7·5	2·015	9·5	2·251
1·55	·438	3·55	1·267	5·55	1·714	7·55	2·022	9·55	2·257
1·6	·470	3·6	1·281	5·6	1·723	7·6	2·028	9·6	2·262
1·65	·500	3·65	1·295	5·65	1·732	7·65	2·035	9·65	2·267
1·7	·531	3·7	1·308	5·7	1·740	7·7	2·041	9·7	2·272
1·75	·560	3·75	1·322	5·75	1·749	7·75	2·048	9·75	2·277
1·8	·588	3·8	1·335	5·8	1·758	7·8	2·054	9·8	2·282
1·85	·615	3·85	1·348	5·85	1·766	7·85	2·061	9·85	2·287
1·9	·642	3·9	1·361	5·9	1·775	7·9	2·067	9·9	2·293
1·95	·668	3·95	1·374	5·95	1·783	7·95	2·073	9·95	2·298
2·0	·693	4·0	1·386	6·0	1·792	8·0	2·079	10·	2·303
2·05	·718	4·05	1·399	6·05	1·800	8·05	2·086	15·	2·708
2·1	·742	4·1	1·411	6·1	1·808	8·1	2·092	20·	2·996
2·15	·765	4·15	1·423	6·15	1·816	8·15	2·098	25·	3·219
2·2	·788	4·2	1·435	6·2	1·824	8·2	2·104	30·	3·401
2·25	·811	4·25	1·447	6·25	1·833	8·25	2·110	35·	3·555
2·3	·833	4·3	1·459	6·3	1·841	8·3	2·116	40·	3·689
2·35	·854	4·35	1·470	6·35	1·848	8·35	2·122	45·	3·807
2·4	·875	4·4	1·482	6·4	1·856	8·4	2·128	50·	3·912
2·45	·896	4·45	1·493	6·45	1·864	8·45	2·134	55·	4·007
2·5	·916	4·5	1·504	6·5	1·872	8·5	2·140	60·	4·094
2·55	·936	4·55	1·515	6·55	1·879	8·55	2·146	65·	4·174
2·6	·956	4·6	1·526	6·6	1·887	8·6	2·152	70·	4·248
2·65	·975	4·65	1·537	6·65	1·895	8·65	2·158	75·	4·317
2·7	·993	4·7	1·548	6·7	1·902	8·7	2·163	80·	4·382
2·75	1·012	4·75	1·558	6·75	1·910	8·75	2·169	85·	4·443
2·8	1·030	4·8	1·569	6·8	1·917	8·8	2·175	90·	4·500
2·85	1·047	4·85	1·579	6·85	1·924	8·85	2·180	95·	4·554
2·9	1·065	4·9	1·589	6·9	1·932	8·9	2·186	100·	4·605
2·95	1·082	4·95	1·599	6·95	1·939	8·95	2·192	1000·	6·908
3·0	1·099	5·0	1·609	7·0	1·946	9·0	2·197	10,000·	9·210

NOTE.—Hyperbolic logarithms express the areas of the irregular spaces or divisions of the rectangular hyperbola, whose conjugate and transverse axes are equal, and whose ordinates decrease in geometrical progression. Common logarithms multiplied by 2·30258 give hyperbolic or Napierian logarithms.

The practical engineer will understand them as a series of numbers which increase in a decreasing ratio, corresponding exactly with the gain by expansion. Their application *supposes the temperature of the steam to remain unaltered, which is not the case in practice*, and the result is always too large. See Major Barnard's articles on Caloric Engines in previous numbers.

Table No. 3.

Relative pressures of Steam expanded to Twenty-Four Times.

	RELATIVE LENGTHS OF ORDINATES WHEN STEAM IS CUT OFF AS FIG. NO. 2.																							
Full pressure =	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Full to expan. =	1/24	1/12	1/8	1/6	5/24	1/4	7/24	1/3	3/8	5/12	11/24	1/2	13/24	7/12	5/8	2/3	17/24	3/4	19/24	5/6	7/8	11/12	23/24	24
Expan. to full =	23/24	11/12	7/8	5/6	19/24	3/4	17/24	2/3	5/8	7/12	13/24	1/2	11/24	5/12	3/8	1/3	7/24	1/4	5/24	1/6	1/8	1/12	1/24	0
1	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
2	·5	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
3	·333	·666	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
4	·25	·5	·75	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
5	·2	·4	·6	·8	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
6	·166	·333	·5	·666	·833	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
7	·142	·285	·428	·571	·714	·857	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
8	·125	·25	·375	·5	·625	·75	·875	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
9	·111	·222	·333	·444	·555	·666	·777	·888	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
10	·10	·2	·3	·4	·5	·6	·700	·800	·900	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
11	·0909	·1818	·2727	·363	·454	·545	·636	·727	·818	·909	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
12	·0833	·166	·25	·333	·416	·5	·583	·666	·750	·833	·916	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
13	·0769	·154	·23	·307	·385	·461	·538	·615	·692	·769	·846	·923	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
14	·0711	·143	·214	·285	·357	·428	·500	·571	·642	·714	·785	·857	·928	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
15	·0666	·133	·2	·266	·333	·40	·4666	·533	·600	·666	·733	·800	·866	·933	1·	1·	1·	1·	1·	1·	1·	1·	1·	1·
16	·0625	·125	·187	·25	·312	·375	·437	·500	·5625	·625	·687	·750	·812	·875	·937	1·	1·	1·	1·	1·	1·	1·	1·	1·
17	·0588	·117	·176	·235	·294	·353	·4116	·472	·5294	·588	·647	·705	·764	·823	·882	·941	1·	1·	1·	1·	1·	1·	1·	1·
18	·0555	·111	·166	·222	·277	·333	·3888	·444	·500	·555	·611	·666	·722	·777	·833	·888	·944	1·	1·	1·	1·	1·	1·	1·
19	·0526	·105	·157	·21	·263	·315	·3684	·421	·473	·526	·578	·631	·684	·736	·789	·842	·894	·947	1·	1·	1·	1·	1·	1·
20	·05	·1	·150	·2	·25	·3	·350	·400	·450	·500	·550	·600	·650	·700	·750	·800	·850	·900	·95	1·	1·	1·	1·	1·
21	·0476	·095	·142	·19	·238	·285	·3333	·380	·4285	·476	·523	·571	·619	·666	·714	·761	·809	·857	·904	·952	1·	1·	1·	1·
22	·0454	·0909	·136	·181	·227	·272	·3181	·363	·4090	·454	·500	·545	·590	·636	·681	·727	·772	·818	·863	·909	·954	1·	1·	1·
23	·0431	·087	·13	·173	·217	·26	·3043	·347	·3913	·434	·478	·521	·565	·608	·652	·695	·739	·782	·826	·869	·913	·956	1·	1·
24	·0416	·0833	·125	·166	·208	·25	·2916	·333	·3750	·416	·458	·500	·541	·583	·625	·666	·708	·750	·791	·833	·875	·916	·958	1·0
Expan. power =	2·774	4·547	5·821	6·762	7·458	7·950	8·277	8·460	8·520	8·467	8·316	8·068	7·741	7·333	6·870	6·320	5·716	5·051	4·334	3·563	2·742	1·872	·958	·00
Total power =	3·774	6·547	8·821	10·762	12·458	13·950	15·277	16·460	17·520	18·467	19·316	20·068	20·741	21·333	21·870	22·320	22·716	23·051	23·334	23·563	23·742	23·872	23·958	24·
Ex. to full as 1· =	2·774	2·273	1·974	1·69	1·491	1·325	1·182	1·057	·946	·851	·756	·672	·595	·524	·458	·395	·336	·281	·228	·178	·130	·085	·041	·00
Mns. of exp pr. =	·1206	·2067	·277	·338	·392	·441	·486	·528	·568	·605	·639	·672	·704	·733	·763	·790	·816	·842	·866	·890	·914	·936	·958	·00
Mns. of total pr =	·157	·272	·367	·448	·518	·581	·636	·685	·730	·771	·804	·836	·864	·889	·911	·930	·946	·960	·972	·981	·989	·994	·998	1·0

*** The Means of full pressure are each taken as a power = 1; and the Expan. and total Means are each their relative proportion to the initial pressure as = 1.

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[From the American Railroad Journal.]

Inside and Outside Connected Locomotives.

THE inside connection was resorted to in the early days of locomotive building, as a remedy against the oscillations caused by the use of inclined outside cylinders and unbalanced drivers. The early engines were built also with a much less length of "wheel-base," or distance between centres of extreme wheels, than now, whereby any sinuous motion was manifested to a greater extent than when divided upon a longer bearing. By applying the power nearer the centre of the axle, sinuous motion was reduced, but the horizontal and vertical motions, due to the action of the unbalanced forces of the piston and connections, remained in their full extent. After a time, counter-weights were suggested, and it was soon found that they would operate beneficially upon all engines. By their aid, the outside connection has become as steady as any other. Now that the sole merit of the inside connection is fully realized in its rival, there are no longer any reasons for its continuance. It must be admitted to involve very serious defects, which are not found in the other arrangement.

First, are the *cranks*, which involve great weight, increased expense, much friction, and considerable danger, besides requiring a very large space in which to work. A crank shaft for a 23 ton engine, weighs 1600 lbs. in the rough, and costs, in that state, from 15 to 18 cents per lb., besides occupying a lathe from six to seven days in finishing. When finished, it will weigh 600 lbs. more than a straight axle of equal strength, which excess is itself equal to the weight of the straight shaft. That is, it is twice as heavy as is necessary. The crank wrists are twice the diameter of the crank-pin of the outside connection, and, as in the case of so large bearings, with the short leverage of a nine or ten-inch crank, the power is not exerted wholly towards the centre of the crank wrist, but is exerted on a large surface, it is apparent that much of it is absorbed in friction. An extreme illustration of this loss may be made evident by a trial to turn an eccentric by power applied through the rod. The liability of failure of the crank is also great, there being very few roads having an equipment of inside connecting engines which do not have a number of cranks broken yearly. During the year 1852, we remember that out of fourteen crank engines in use on the Boston and Providence Road, there were eleven cases of broken cranks. The renewal of a crank costs a large sum besides the cost of the crank itself and the expenses of finishing it, as it requires a considerable detention of the engine, and the labor of drawing off and on the wheels, re-setting valves, &c. Cases of failure of cranks are very frequent on other roads, and serve to swell largely the cost of engine repairs. All the objections which we have enumerated against the crank, are endured on the majority of New England Roads.

The space required for the crank is a very serious objection to it. It occupies a great deal of room laterally, vertically, and horizontally. Laterally the two cranks occupy from 29 to 30 inches of the length of the axle between the boxes, which distance does not exceed 40 to 41 inches, leaving but a short space in which to crowd the valve motion. The demands for the latter purpose have always been a favorite point in the arguments for a broad gauge, when in reality it was the necessary arrangement adopted for the locomotive, and not the incapacity of the gauge that causes the difficulty. Vertically, the space demanded for the crank is a great objection, as the centre of the boiler must be as high from the rails for a 5 feet wheel, inside connected engine, as for a 6 feet 6 inch wheel, outside connection. The crank limits, by from 18 inches to two feet, the diameter of the driving-wheel; and in any case, upon a road having low bridges and station doors, limits the proper height of the chimney by from 9 inches to 1 foot. The cylinders are placed at a distance of 24 inches between centres, in the usual plan of inside connection, whereby the curve of the under side of the boiler saves but four inches for the clearance of the crank, over what would be had by placing it directly under the centre of the boiler. A 10 inch crank with 7 inch journals, and with the strap and key of the connecting-rod, and the vertical allowance for the motion of the springs, will require a distance, therefore, between the centre of the axle and the under side of the boiler, of at least 14 inches. But the crank does not alone limit this height; the link motion, which all builders are adopting, requires on an inside connection, a still greater height, so that 16 inches to 17 inches from the centre of the driving axle to the under side of the boiler, is quite a common allowance of height. This is from 10 to 12 inches more than the outside connection requires. Horizontally, the crank limits the length of the furnace, which is especially injurious in cases where a powerful engine is wanted on a short wheel base. Many of the engines built at the present day for western roads, and destined to use green wood, have furnaces of from 4 to 5 feet outside length, the latter of which, with an inside connection, would require a distance of nearly 7 feet between centres of drivers.

The crank engine also involves other objections. The off-set frame required by it is not as strong, as simple, and as cheap as the straight frame. The valve motion for an inside connection must always be crowded, laterally and vertically. The rocker arms must be short, and off-set valve rods must be made. In cases of low-wheeled engines, the cylinders occupy the room which should be devoted to the truck; and with a centre-bearing truck, there is not near room enough to get a proper depth and strength of truck-frame, and at the same time to allow of a truck wheel of proper size. Again, the modern practice of builders of outside connections is to give from 22 to 26 inches stroke of piston for freight and passenger engines. This is generally approved of by railroad engineers and managers, as making, with the larger wheel it allows, a steadier engine, and as reducing the wear of the machinery. But to increase the length of the inside crank, from 9 or 10 inches up to 12 or 13, would increase all the evils we have named, as it would require a heavier crank shaft and greater expense and friction, and at just as much danger of breakage, besides occupying more room, laterally, vertically, and horizontally.

As an application of our strictures upon this class of engines, we will notice the motive power of many of the New England roads, and especially of those running directly out of Boston, which assume to be equipped in first class style, and yet upon no one of which is there a modern and first class example of an outside connected passenger engine. Many of these roads have as good engines as can be expected in the use of crank engines, being of good proportions and workmanship. We instanced, in a previous number, the motive power of the Boston and Providence Road, which for good construction and proportions, will compare well with any in Massachusetts. The necessity for steady engines running at high speeds is as great on these, we presume, as on any road, while the character of their track is already favorable for these ends. And yet the speed upon the New-York Central and Hudson River Roads, of the same gauge, and on the Lake Shore, New Jersey and Cleveland, Columbus and Cincinnati Roads of 4 feet 10 inches gauge, is greater than upon any of these roads. The size of driving-wheels of all engines on roads entering the city of Boston, is limited also to but 5½ feet, while the greater part of the passenger business is done by engines having but 5 feet wheels. The Boston and Lowell Road, built, and of the assumed character of a first class work, having no grade of over 10 feet per mile, except for a short distance near the Lowell station, and no bad curves, has but 2 engines, out of an equipment of 22, having drivers as large as 5½ feet. One of these has been rebuilt from an engine originally made by the Lowell Machine Shop, and from our own observation, we can pronounce it more unsteady than the majority of outside connected engines on the New-York roads. Other crank engines, upon which we have rode on this line, are subject to very severe fore-and-aft oscillations, and the motive power generally upon this road is of an inferior class. The bridges on this line are very low, not much, if any, above 13 feet from the rails, and the consequence is that only a very low chimney can be obtained, as the boilers set very high. The same disadvantage of low chimneys is also experienced by most of the other roads in the vicinity, most of the roads running out of Boston having bridges of less than 13½ feet from the rails, while the engines are inside connected, and have very high boilers.

The motive power of these roads is "behind the times" in character and capacity. And the reason for it is, that these lines have never been influenced by that competition which must be the source of improvement in railway machinery. The motive power of New England roads has been fixed by the builders, and these have been in no ways hasty to adopt or encourage improvements. While the builders have sent work to distant markets, in which they have been compelled to compete with more stirring manufacturers, they have made efforts for improvement, but these have usually taken the shape of copies, and these not always faithfully rendered. When the New-York and Boston Railroad shall be opened for travel, and stocked, as it will be, with motive power in every respect first class, these builders will adopt some essential changes in their patterns. The outside connected engines by the Amoskeag Company, of Manchester, and by Messrs. William Mason & Co., of Taunton, are nearest to the standard to which these changes must conform.

In making these remarks, it is necessary to defend the outside connection from some charges which are made by those who call the Boston style of outside connection a fair sample of that arrangement. The cylinder attachment afforded by the outside connection has been pronounced by New England builders as less strong than that obtained by the inside connection. With the attachment of cylinder usually adopted by such of those builders as have made outside connections, we not only admit this as true, but emphatically indorse it. They have secured the cylinders, by a light flange on each, to the inside frame, and have bolted to a light rail placed on edge on the outside. These always work loose after use, and especially where put to a hard strain. We have seen plenty of illustrations of this effect. Now we will venture to affirm that the cylinder attachment of the Paterson engines is more secure than that of any inside connected engines ever built in Boston. The smoke-box is made of sheets ⅜ inch thick, with a bar of 2 inch square iron riveted around the forward edge, on the inside; the sheets are of double thickness, or ¾ inch, where the cylinder is bolted on; the flange of the cylinder rests upon the frame, while another wide flange reaches high up on the side of the smoke-box, affording all the permanence of attachment that can be obtained by any plan. The cylinder attachment of the engines by the New Jersey Locomotive Works, which is made to a round smoke-box of double thickness at the bottom, affords another instance of great strength of connection. There are other engines having cylinder attachments different from these, but affording, at the same time, all the security which can be required.

The steadiness of the outside connection has been well demonstrated, and those who like to be convinced by practical illustration can be accommodated by testing the motion of the engines on the numerous roads we have cited as using this connection.

The objection to the radiation of heat by the exposed position of the outside cylinder, is one which can well be thrown onto the Boston-built engines in its full force, as none of these have any adequate protection for their cylinders and chests, while the Paterson engines, and the fine new outside connections built by Mason & Co., at Taunton, have ample protections of this kind, while the result of their use shows that no loss of power can be detected in their performance.

As a conclusion to this subject, we will give a list of the locomotive shops in the country, with the connection which they have generally adopted.

Portland Locomotive Works, Portland, Me.,	*Inside.*
Amoskeag do. do. Manchester, N. H.,	*Both.*
Lowell Machine Shop, Lowell, Mass.,	*Inside.*
Essex Co., Lawrence, "	*Both.*
Boston Locomotive Works, Boston, Mass.,	*Inside.*
for passenger engines, for freight,	*Outside.*
Seth Wilmarth, Boston, Mass.,	*Both.*
John Souther & Co., "	*Inside.*
William Mason & Co., Taunton, "	*Outside.*
Taunton Locomotive Co., "	*Inside.*
Breese & Kneeland, Jersey City, N. J.	*Outside.*
Rogers, Ketchum & Grosvenor, Paterson, N. J.,	"
New Jersey Locomotive Works, Paterson, N. J.,	"
Danforth, Cooke & Co., Paterson, N. J.,	"
William Swinburn, " "	"
New Castle Manufacturing Company, New Castle, Del.,	"
Richard Norris & Son, Philadelphia, Pa.,	"
M. W. Baldwin, " "	"
Ross Winans, Baltimore, Md.,	"
Murray & Hazlehurst, Baltimore, Md.,	"
A. W. Denmead & Son, " "	"
Smith & Perkins, Alexandria, Va.,	"
J. R. Anderson, Richmond, "	"
William Ettenger & Co., Richmond, Va.,	"
Schenectady Locomotive Works, Schenectady, N. Y.,	"
Cuyahoga Furnace Company, Cleveland, Ohio,	"
Niles & Co., Cincinnati, Ohio,	"
Moore, Richardson, & Co., Cincinnati, Ohio,	"
A. L. Greer & Co., Covington, Ky.,	"
H. & F. Blandy, Zanesville, Ohio,	"
C. Cooper & Co. Mount Vernon, Ohio,	"
Nashville Manufacturing Company, Nashville, Tenn.,	"
C. A. Olmstead & Co. Louisville, Ky.,	"
H. H. Scoville & Son, Chicago, Ill.,	"
Palm & Robertson, St. Louis, Mo.—no information received.	

Almost the whole number of those shops designated as building the outside connected engine, have adopted that arrangement to the exclusion of any other.

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Use of Magnetic Attraction in Locomotion on Railroads.

By M. J. Nickles.

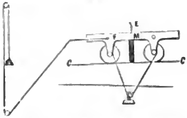
We recommend to attention the following, from the November number of Silliman's Journal of Science. We have, as usual, interlined the corresponding English measures.

The researches here described have been in progress three years. Their object has been to give to the driving wheels of locomotives a power of adhesion independent of pressure or weight, an adhesion, consequently, that will not vary with the grade, and which, at the same time, may be suspended or brought into action at will.

My first experiments were made in conjunction with a Paris mechanician, M. Amberger, who had called my attention to this subject, by consulting me as to the means which physical science could furnish toward it. My first idea was to make the driving wheels electro-magnets; but not finding in known facts sufficient data for magnetizing a wheel in motion, I undertook provisionally to use an electro-magnet, acting at a distance, upon the rail, and fixed upon a support moving upon the railroad.

This apparatus consists of a framework of iron F (fig. 1), moving on 4 wheels in pairs, to which a rotatory movement is imparted by means of a weight B, acting on the wheels in place of steam.

Fig. 1.



Another weight A, fixed at the extremity of the car by means of a cord, represents the resistance, or the charge to be drawn.

This car was placed on a railroad C, whose grade could be varied. At M it carried a horse-shoe magnet E, placed across the track, and so that its arms were separated by the distance between the rails. This electro-magnet, one arm of which only is represented in section in fig. 1, consists of a bar of iron 1 centimeter [=·3638 inches], in section, bent into a horse-shoe form, and having each arm furnished with about 250 turns of copper wire, 1 millimeter [=·3938 inch] thick. The poles of this magnet were about 4 millimeters from the rail on which they were to act. The pile consisted of two of Bunsen's elements as modified by Deluil.

The first experiment was made on a grade of 80 millimeters to the meter [=222½ feet to the mile]. The car was put on the rails, and the weight B left to fall by its gravity, and so give motion to the wheels about which the cord was wound. Under this force, the car tended to pass over the rail, and motion began when the weight A was removed; although the adhesion was sufficient for transporting its own weight, it was not enough to balance the resistance exerted by A (A representing the train to be drawn). The addition of the electro-magnet was intended to give to the driving wheels this supplement of adhesion, and in fact, on closing the circuit, the car passed over the rails without difficulty; on breaking the connection again, it stopped and fell back on the track. The weight A used in the experiment was 2 kilogrammes,* and the motor weight B about 6. The figure is reduced to one fifth the lineal dimensions.

In this experiment, the adhesion derived from the weight of the engine was obviously replaced by another force differing in being independent of the grade of the track, since the magnetic attraction always acts perpendicularly to the plane of the armature, whatever may be the position or inclination, while gravity acts at right angles to a true horizontal plane. The constancy of the magnetic adhesion is proved by means of a piece of apparatus which is described below.

Fig. 2.

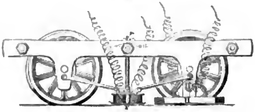
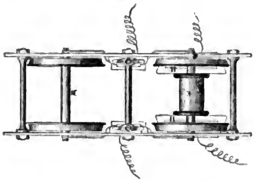


Fig. 3.



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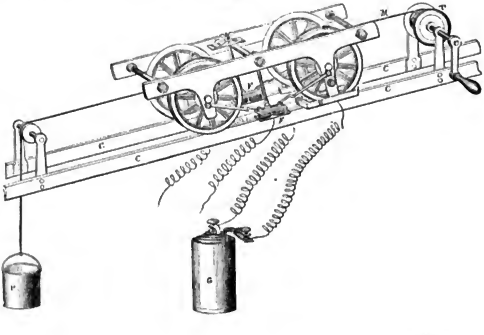
* A kilogramme is 2·204737 pounds.

Fig. 4.



Although this experiment was so simple and unpretending, it afforded an encouraging demonstration of the problem in view, and it has interested the different professors of physics of Paris, MM. Despretz, Becquerel, Silbermann, &c., who have exhibited it in their courses, as well as the other experiments below detailed.

The process just explained would certainly have been very simple, if the successful application on a large scale had required only that an electro-magnet should be placed on each side of the driving wheels. But this method would not stand the most elementary considerations. The attraction diminishes as the square of the distance; and, moreover, the magnetic adhesion not exceeding 1-10th the power of the magnets at 4 millimeters distance—since the adhesion is, at a mean, 1-10th of the pressure—the required force would not be realized even with batteries of great power.

The only possible method seemed then to consist in magnetizing the point of contact, which was accomplished as follows. Figs. 2 and 3 represent different views of a small car, which, in fig 4, rests on a railroad. The driving wheels of this car are surrounded in their lower part by a helix H, containing a conducting wire wound a certain number of times on itself, and constituting thus a true magnetizing helix. It is fixed, and embraces the lower part of the wheel; its inner sides are far enough apart for the wheel to turn freely without touching the helix. On passing the electric current, the wheel feels the two fluids, one, the boreal, for example, influencing the part of the wheel above the helix, the other, austral, the lower portion; and as the helix is placed as near as possible to the point of contact, this last portion must be more strongly magnetized than the upper, the austral being concentrated on the smaller space.

The apparatus in figure 4 served to verify these different effects. The roller T is for receiving the cord which is wound upon the motor axle E (fig. 3), and which corresponds to the moving power; P represents the train to be transported.

The weight P is increased until the car is ready to slide back; as soon as the motion ceases, the current is let on, and immediately the car starts off and draws the weight P; it descends again, if the circuit is broken, and reascends on establishing it again, and so on.

In this apparatus, each of the helices, H and H′, consists of a brass box, containing each 8 meters [about 26 feet] of copper wire of $0^{m}\cdot0071$ [about ¼ inch] in diameter, distributed in 77 turns, or 16 meters, and 154 turns for both. The cord which sustains the weight P is fixed on N (fig. 3), and passes over the pulley behind; G represents a voltaic couple; C a railroad track, arranged so that the grade may be varied.

The following trial gives nearly the relations existing between the two modes of adhesion operating in this apparatus, and between the pressures which produce the adhesion.

Weight of car 5 kilogrammes. Grade 190 millimeters to the meter [about 1000 feet to the mile]. One element of a battery of gas carbon. Total current tan 35° 10′. Reduced current of the helices, tan 18° 25′.

Weight required for Motion.		Sum of Adhesions.	Additional Weight required to replace the Magnetic Adhesion.
Ordinary Adhesion.	Mag. Adhesion.		
5·500 kil.	5·100 kil.	10·600.	3·500.

The two driving wheels were fixed to the rails with a magnetic force equivalent to 3½ kilogrammes;—this force was measured by means of a dynamometer, with which the car was detached in a direction perpendicular to the plane of the track.

This experiment clearly proves, that between the magnetic pressure and its adhesion, there is the same relation as between the ordinary adhesion and the pressure by added weight. From another experiment, we have also learned that the same relation subsists between the attraction exerted by an electro-magnet, on a surface of iron, and the weight required to make it move. The magnetic co-efficient for moving equals closely the co-efficient afforded by a mass of iron, whose weight was equal to the magnetic pressure exerted by the electro-magnet.

In the apparatus of figure 4, there is also on each side an electro-magnet F, fixed to the grease-boxes, and suspended by means of springs *r*. These electro-magnets act as a check; unlike the checks in use on railroads, they act upon the rails, and thus preserve the wheels which are rapidly worn by the ordinary checks; there is nothing to prevent making the magnetic checks to act upon the wheels. In either case, a power as energetic as desired may be developed, whose intensity may be varied at will, from that required to produce an instantaneous arrest of the motion, as in cases of imminent danger, to that for ordinary stoppages.

These different effects were produced with the small car represented in figure 4. The element of a galvanic battery here employed, gives a force sufficient to stop the car instantly, even when driven at full speed it arrives at the bottom of a grade of 190 millimeters. By diminishing the current or augmenting the charge, we produce, on the contrary, an effect which retards the motion of the vehicle, and ends by stopping it altogether. By interrupting the current and re-establishing it in turns, the car may be made to leap along the track. These different effects, which are not well attempted with a large train, are readily shown on a small scale, and are calculated to interest much the young student.

But it will be understood that my researches aim not merely to exhibit a new property of electro-magnets, and combine them in instructive apparatus. My plans are of another kind. They seek to contribute to railroads, a new and important improvement, and I shall not be satisfied until it has become easy to use grades of more than 10 millimeters to the meter, and until it shall become no longer necessary to construct tunnels at great expense, or to build extensive earth-works, or make curves of large radius. Of what avail otherwise the efforts to give a smaller size to the driving wheels, less weight to locomotives, and lighter rails to the road, thereby to make a large diminution of expense in the construction and use of roads? If a smaller and lighter driving wheel be invented, the adhesion must be imparted to it which it fails of having on account of its lightness, and hence it must be useless under the old system, which works upon the paradox of making a machine run better by giving it more weight.

I have, therefore, sought to pass from the laboratory experiment to the actual locomotive in its own field. I have made my trials on the road between Paris and Lyons. The locomotive put at my disposal was, in truth, somewhat worn by long service, and one of its driving wheels carried a ton of weight more than the other. I was not allowed to make any changes in the machine, and I was required to attach my apparatus in such a way that it might be easily removed. Notwithstanding the unfavorableness of these conditions, I went to work, certain of having an effect sufficient to prove the application possible. This was admitted by a commission appointed by the Minister of Public Works, consisting of MM. Pouillet, Regnault, Froment, Le Chatelier, Chatelus, and Sauvage, chief engineer of the Lyons Railroad. The useful effect observed in this experiment was about 9 per cent.

Under the new conditions, obstacles were encountered which were unknown in my laboratory researches. Still, without modifying the wheels, which was not allowed, I undertook to apply the method of magnetization above described.

As the experiments have led to some curious results not devoid of scientific interest, I will enter into some details which may, at least, serve for verification, and will excite the attention of physicists engaged in this department of electro-magnetism. The points which will especially engage my attention in this essay will be the battery, and particularly the helices. The helices, when once constructed, must remain as they are, while, by the different modes of combination of which a battery is susceptible, we can always apportion more or less the tension of the fluid to the resistance to be overcome.

Helices of Magnetization.

Considering only the works hitherto published on magnetization, the nature of helices should be easily resolved. In fact, according to Dal Negro, Fechner, Lenz, and Jacobi:[*]

1. *The magnetic intensity developed is proportioned to the intensity of the current.* The nature of the application is opposed, it is true, to a galvanic development of great power; but it may be supplied, if, as Lenz and Jacobi conclude,

2. *The attraction is proportioned to the intensity of the current multiplied by the number of turns in the helix;* and with much more reason, if, as says M. Dub,[†]

3. *The magnetic attraction developed is proportioned to the square of the current, multiplied by the square of the number of turns of the spire;* a law which, ten years since, Mr. Joule[‡] expressed in the formula, $M = E^2 W^2$, M representing the magnetism developed; E the quantity of electricity in activity; and W the length of the conductor.

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[*] Poggendorff's, Ann. xlvii. 225.

[†] Poggendorff's Ann. (7), lxxxi. 46.

[‡] Phil. Mag. (4), vii., 309, and Annals of Elect., i., 470.

Moreover, MM. Lenz and Jacobi, say that "*the section of the conducting wire is without influence on the magnetizing force, provided the galvanic intensity does not vary;*" and as the resistance offered by the conductors is proportional to their length, and inversely as their section, a battery and helix may be constructed such, that the number of turns of the helix shall be the greatest possible. Happily I have had occasion to observe that Mr. Joule's formula is not exact, or at least does not apply in such a case as this; the law of magnetic maximum of M. Müller is, on the other side, opposed to it.

These doubts and contradictions, and the necessity of further experiment, complicate much the problem in hand. I have, however, succeeded in meeting the several points, and in making the resistance of the battery equal with that of the conducting wire, without too considerable a development in either the battery or helix. The wire was $4^{mm}{\cdot}5$ in section, with a total length of 1036 meters; each helix received 518, forming 216 turns.

The battery consisted of 64 elements of Bunsen made with gas carbon; the surface of the carbon in each element was $0^{m}{\cdot}911$; that of the zinc immersed $0^{m}{\cdot}9148$. These 64 elements were arranged in 8 cases, having each compartment covered with gutta percha, as has been done by Professor Page. The whole was placed behind the tender. In this position the battery was out of the way, and hardly seen in the train.

The battery, whether arranged for tension, or coupled for quantity in series of 32 elements with double surface, produces the same results, whenever an equivalent direction is given to the current. Thus, when arranged for tension, a single current is produced; and when for quantity, the current is diverted on arriving below the machine, so as to form a distinct current in each helix; two conductors of copper wire answer in this experiment, which is not quite delicate in other respects on account of the excessive conductibility of the materials which enter into the construction of a locomotive. These conductors were lodged in tubes of gutta percha, which were themselves covered with chamois leather, that was impregnated with varnish, especially where these tubes are directly supported by iron. On reaching the point of junction of the tender with the machine, these conductors are adapted to the conductors fixed to the locomotive, being bifurcated with them in a way to avoid rupture from the vibration of the cars while in motion. From thence, they follow the left side of the locomotive, penetrate under the machine between the furnace and one of the driving wheels, and are then continued parallel to the machine, half way to the helices. Being firmly fixed to the points of attachment presented in great number under the machine, these conductors are denuded where they receive the extremities of the wires proceeding from the helices. These last were suspended to the grease-boxes by means of strong clamps and a plate of iron.

Thus arranged, one of the conductors is continuous from one extremity to the other; the other conductor, on the contrary, has a break produced by the commutator. On arriving near the iron seat ("coffre") on the front of the tender, breast-high, this conductor diverges from the line which it has before followed, and is secured to the extremity of a plate of platanized copper, attached solidly to the seat, and carefully insulated. The other side of this connecting plate is destined to receive the extremity of the interrupted conductor, which is in contact with one of the poles of the battery.

This part of the conductor is flattened, so as to present a convenient surface; a spring holds it off from the plate, and in this state the circuit is open; to close it, a key is touched, which acts on the conductor, and presses it upon the connecting plate; and it is broken by a contrary movement, when the spring throws off the conductor.

On making the battery connection, a magnetic radiation is perceived to a great distance, so that at 5 meters from the wheel in the plane of the helix, small strips of iron may be magnetized.

The result of the experiment made with the apparatus just described, has been made the subject of a report to the Minister of Public works, by the commission already named. The following numbers are cited from this document.

The trial was made on a grade of 10 millimeters to the meter. The elements of the machine were as follows:

	Meters.
Diameter of pistons,	0.400
Play of the pistons,	0·600
Diameter of the driving wheels,	1·600
Heating surface of the fire,	779·600
" " tubes,	7·860
Weight of the machine provided with its water and coke,	29 tons.
Load on the rails to be drawn by the driving wheels,	14 tons.
Pressure of the boiler,	6 atmospheres.
The whole train, about	119 tons.
The rate of motion, per hour,	15 kilometers.

Under a pressure of 7 to 8 atmospheres, the locomotive slid easily over the rails, when the galvanic circuit was open; the movement ceased when it was closed, and began again when again opened. To make the locomotive move in spite of the magnetism, a pressure of 9 atmospheres was required with a risk of bursting the boiler, which was registered for 6 atmospheres. Under this pressure, the driving wheels moved in both cases, yet with an apparent difference, when the wheels were magnetized.

The additional adhesion from magnetism was thus proved, although it was less than could have been obtained with a more convenient arrangement. In fact, the particular process followed in this trial, did not retain the magnetization quite constant at the point of contact of the wheels; this magnetization diminished with the rotation, as shown in the following table, which gives the results of trials with a single wheel, from rest to a velocity of 18 kilometers an hour.

Turns per min.	Kil. per hour.	Pressure due to Magnetization.	Relation of *additional* pressure to the *ordinary* pressure on the rail.
0	0	639 kil.	12·5 to 10·6 p. c.
30	9	255	5·1 to 4·8 p. c.
60	18	165	3·3 to 2·7 p. c.

In this experiment the wheels did not rest on the rail as in ordinary conditions: by means of the grease-box reversed of each, they were fixed upon a framework for their support; two wooden pulleys were arranged on the motor axle; these pulleys, in connection with the power wheel of the workshop, were calculated so as to furnish the two velocities of rotation, registered in the table. The rail placed below each wheel was movable at one of its extremities, around a bolt, and carried at the other a box of zinc for receiving the weight necessary for detaching the rail from the wheel, when it was suspended by the magnetizing action; a reservoir of water, divided into litres, was arranged so as to turn into each box the water necessary for breaking the connection.

Knowing the length of the rail, its weight, the same of the box of zinc, and the quantity of water required from the reservoir, we may, by a simple calculation, ascertain the amount sustained by the point of contact, and thence the pressure due to the magnetization, either during rest or rotation.

In this way the table above has been obtained. The decrease observed during rotation was also exhibited in the following manner: The rail resting at its free extremity on a block of wood, and being separated from the wheel by an interval of 0·17 metre, a small magnetic declination needle placed at a distance of 0·75 meter from the rail, was moved along the wheel, in order to ascertain the points where its direction was perpendicular to the plane of the wheel.

When the wheel was at rest, the needle took a position vertical to the rails only when in a vertical plane passing by the axle, and, consequently, at the point of contact with the wheel. When, on the contrary, the wheel was in motion, it was necessary to change the place of the needle, moving it backward (in relation to the direction of the movement of the wheel), in order to obtain the direction normal to the rails. This change of place amounted to 0·33 and 0·39 m. for velocities corresponding to rates of 18 and 36 kilometers to the hour.

These observations show that the resultant of the magnetic forces which passes by the centre of gravity of the helix, and, consequently, by the point of contact of the wheel when it is in repose, becomes displaced during the movement, and is no longer identical with the point of contact. This arises from two distinct causes. At the moment of entering the helix, the portion of the rim of the wheel under consideration experiences a first effect of magnetization, tending to impress upon it a polarity conformed to that part of the helix which is opposite to the point of contact. Reaching this point, it should be at its maximum power; but in presence of the contrary fluid of the superior part of the helix, its magnetism diminishes while it is rising and moving from the helix, and the fluid has changed its name when the rim has arrived at the emergence. These contrary effects of magnetization and demagnetization, and, subsequently, of inversion of the fluid, might be made of use, if, contrary to the fact, the rim was made of soft iron, having no coercitive force. Hence, at each revolution, the wheel is subject to double magnetic work, which is unequal, and must give to the resultant of the magnetic actions a position of equilibrium different from that existing when the wheel is at rest.

At rest, the wheel does not differ from an ordinary electro-magnet; like it, it is divided into two parts magnetically distinct; the turns of its helix are parallel to the plane of the armature; the resultant of the magnetic actions developed by the helix is perpendicular to this plane, and passes by the centre of gravity of the helix. The position of the pole is then subordinate to that of the helix. If the former is displaced 0·33 meter it is only necessary to move the helix forward a corresponding quantity to remedy the displacement of the pole, which will be easily managed, if no other improvement is required.

One of the most important improvements consists in the possibility of bringing into simultaneous action the two magnetic poles, to profit by the increase of force that always takes place when both poles act together on an armature. The trial reported by me in this Journal,* evinces the importance of this condition.

The improvements which I have explained, as regards the general principle, in the July number of this Journal, in my article on circular electro-magnets, aim principally towards—

1. Preventing the displacement of the poles.
2. Giving constancy to the magnetization of the wheel.
3. Bringing both poles into concurrent action.

The concurrent action of both poles is made certain by the check described above, as well as by the more convenient electro-magnet which I have made known in the January number of this Journal, and which may be also of use as a check on railroads.

The researches which I have here described, constitute the first part of my experiments. It would have been difficult to have carried them thus far, if I had not found in one of the most distinguished engineers of France, a Mæcenas who appreciated at first sight the importance of my labors, and by a rare generosity enabled me to undertake these researches. M. Bazaine, in whose life many facts of the kind might be mentioned, needed not this new act of disinterestedness, that his love of progress should be known. He was among those who introduced railroads into France, and he gave the country its first great road, that from Strasbourg to Basle.

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LIST OF PATENTS

Issued from the U. S. Patent Office during the month of Oct., 1853.

C. R. Brinckerhoff, of Batavia, N. Y., for Ploughs.

Claim.—First, combining the plough beam between the plough and the clevis, two wheels, one on each side of the beam, and of different diameters, the one resting in the furrow, and the other on the land, as described.

Second, I also claim making the tread of the furrow wheel narrow, for the purposes described.

I also claim making the said wheels, especially the furrow wheel, adjustable in the direction of its axis, for the purpose of adapting its position to furrows of different widths.

I also claim making the furrow wheel bevelling outward on the side which presses against the land, as set forth.

I also claim making the small wheel adjustable, vertically, with reference to the shaft and the large wheel, as described.

H. P. Byram, of Louisville, Ky., for Hullers for Grass Seed.

Claim.—In combination with the rubbing or scouring wheel, the method of feeding up and holding against the said wheel the seed to be cleaned by a pressure which is unvarying, whether the hopper is full or not, as described.

John B. Collan, of Reading, Pa., for Detachable Lining for the Fire Boxes of Steam Boilers.

Claim.—A detachable lining for the sides and ends of fire boxes of steam boilers, consisting of one or more tubes connected with the adjacent water space, by means of hollow bolts, or their equivalent, as set forth, so as to admit of the ready removal and replacement of the tubes.

Gilman Davis, of Roxbury, Mass., for Ash-Pans for Locomotive Engines.

Claim.—Taking in the air in front of the ash-pan, and introducing it into the fire box in a direction opposite to the furnace doors, to protect the fireman from the back lash of the fire, when said doors are opened, by means as described.

S. G. Dugdale, of Richmond, Ind., for opening and closing Gates.

Claim.—First, opening, closing, fastening, and unfastening the gate, by moving the bottom of the gate in an oblique direction from and to the post upon which it is hung, as specified.

Second, I also claim the use of the pendulous and vertical levers and arms, in combination with the hinges of the gate, as set forth.

Charles Goodyear, of New Haven, Conn., for covering Iron with Gutta Percha.

Claim.—The art or method of coating articles composed wholly or partly of metal, with compounds of caoutchouc or gutta percha, and subjecting the same to a high degree of artificial heat, or the process of vulcanization, as specified.

N. Harrison & J. W. H. Metcalf, of Ridgefield, Va., for Hill Side Ploughs.

Claim.—Curving downward and inward the beam in the rear part, so as to cause it to support the rotary part of the plough, which it performs in combination with the standard, as set forth.

Joseph Harris, Jr., of Boston, Mass., for driving Circular Saws.

I do not claim driving pulleys by their surfaces coming in contact with each other, that method having before been used.

Claim.—First, the method of hanging the arbor frame on journals, for its axis each side of the driving pulley bringing the axes of the arbor frame within the circumference of the driving pulley, or on a line passing through the driving pulley, in such a manner and at such an angle with the tangent to the driving pulley, that the act of feeding the stuff to the saw or cutter will press the arbor pulley against the driving pulley, as described.

Second, hanging the arbor frame on such an angle, that the act of feeding the stuff to the cutter will press the arbor pulley against the driving pulley, in combination with a spiral spring, or its equivalent, for holding the arbor pulley firmly against the driving pulley, as described.

Daniel Hill, of Bartonia, Ind., for attachment of a Harrow to a Land Roller.

Claim.—The arrangement and mode of attaching the harrow to the forward axle of a roller, as set forth.

T. B. Jones, of Carlovilla, Ala., for Cob and Stalk Cutters.

Claim.—The combination of the feeding trough, its gauge disc, the tube, and its gauge-ring, with the knives, whereby the same knife will, at the same time, cut fodder coarse and cobs fine, and thereby improve the quality of the product as feed for animals.

H. M. Keller, of Newark, Ohio, for Winnowers of Grain.

Claim.—The trap door, in combination with the screen, arranged and operated as set forth.

J. J. Parker, of Marietta, Ohio, for Straw Cutters.

Claim.—Operating both the reciprocating gate and the feeding rake, by means of the compound spring pitman, substantially as herein set forth.

Samuel Snow, of Fayetteville, N. Y., and Alexander Hine, of La Fayette, N. Y., for Rotary Root-Digging Cultivators.

Claim.—The combination of the two-toothed cylinders, with the receiving box, all being arranged and suspended on an adjustable frame, in the manner set forth.

Jacob L. Van Valkenburgh, of Ogdensburgh, N. Y., for Shaking Shoes for Winnowers.

Claim.—I do not claim the use of sieves in cleaning grain, but the communication of reciprocating rotating motion to the sieves or separators, and also the construction of the machine in the manner set forth for separating grain from cockle, &c.

Horace W. Woodruff, of Watertown, N. Y., for treating Metals while in the Molten State.

Claim.—Treating metals while in the molten state, to expel impurities therefrom, by immersing therein some porous or cellular non-conducting substance or substances containing liquid matter, substantially as specified.

D. H. Whittemore, of Chicopee Falls, Mass., for Vegetable Cutters.

Claim.—the combination of the long and short knives on the periphery of the cylinder, with the hopper arranged and described as represented.

H. G. Robertson, of Greenville, Tenn., for Washing Machines.

Claim.—The employment of the double-chambered slatted bottom tub, in combination with the vibrating or rocking frame, constructed with two hinged slatted wash-boards, which have cords passing under the bottom of them, for holding the clothes against their bottoms while washing, the said boards being made movable or swinging, so that the clothes can be easily laid on the cords; and also being set in such a position, that they and the clothes will always be caused to strike parallelly the slatted bottom and the hot suds in the tub, and force the latter through the pores of the clothes, and cause them to be washed clean, the whole being constructed and arranged and operated in the manner described.

Banford Gilbert, of Pittsburgh, Pa., for Griddles.

Claim.—Constructing griddles of two pieces, separated by flanges furnished with openings to admit of the passage of cool air between the upper and lower pieces of the griddle, which openings may be closed at pleasure, as described.

A. B. Latta, of Cincinnati, Ohio, for Oscillating Engines.

Claim.—The mode of arranging the valve chambers outside of the barring or trunnion on which the cylinder oscillates, in such a manner as to allow the wrist-pin of the eccentric rod to move equally across the centre of the trunnion, and moving equally above and below, and thereby giving motion to the valve or valves by said eccentric, independently of the oscillating of the cylinder.

I also claim the sliding bar or bars to which the eccentric is attached, and passing up the whole length of the valve chambers to the end or ends, as the case may be, and attaching to the valve rods, thereby giving motion to the valves.

I claim these arrangements, or their mechanical equivalents.

Leland Foreman, of New-York City, for Life Boats.

Claim.—Constructing the body of my life boat wholly of metallic tubes, brazed or similarly united throughout, thus affording a water-tight and solid metallic connection, and mutual bracing of every part, as shown, whereby are attained the objects explained, in a compact and generally advantageous manner.

I further claim, in combination with such boat, the detachable tubular seat, as described.

William Stephens, of Pittston, Pa., for Valve Motion of Oscillating Engines.

Claim.—First, the combined arrangement of the slide valve and the guide, which assists the oscillation of the engine in producing, and directs the motion of the said valve, as described, to wit, the valve being arranged to work transversely to the cylinder, and the guide being in the form of part of a helix or screw, concentric to the axis of the cylinder's oscillation, and receiving an arm or cross-head, attached directly to the rod or stem of the valve, whereby the intermediate mechanism usually employed is dispensed with.

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* Silliman's, vol. xv. p. 104, Jan., 1853, and p. 360, May.

Second, giving the valve the necessary or desired lead, by means of the adjustable sliding lining pieces, which line the sides of the guide, and are furnished with projecting or rising parts, which will give the necessary lead in working the engine in either direction, as set forth.

John A. Elder, of Westbrook, Me. (assignor to John A. Coffin, of Portland, Me.), for cutting Binders' Boards.

Claim.—First, the arrangement of machinery for cutting pasteboard into strips, and those strips a given length at the same time.

Second, the arrangement of the rocker shaft, rolls, and shears, as described.

Third, I also claim the series of shears, or its equivalent, for the purpose described.

L. M. Whitman, of Weedsport, N. Y. (assignor to S. G. Wise), for Cultivating Ploughs.

Claim.—The employment of the long-inclined spring wings, secured at their front ends to the share and main standard, and turning upon the pin, in combination with the mechanical contrivances shown, for expanding and contracting the wings, or setting them more perpendicular and nearer together, for the purpose of throwing more pulverized soil against or up to the hills, or setting them less inclined to the horizontal plane, and further apart, for the purpose of allowing the pulverized soil, weeds, &c., to pass over them into the board open spaces in the centre, the said wings in either case cutting up the weeds and pulverizing the soil, as set forth.

Ebenezer Beard, of New Sharon, Me., for Propellers.

Claim.—The use of one or more flanges or rims placed circumferentially upon the blades of a screw propeller, as described.

E. B. Bowditch, of New Haven, Conn., for Sofa Beds.

Claim.—The arrangement of hinging the ordinary sofa seat to the back rail of the sofa frame, in combination with the arrangement of hinging an under seat with the upholstered side down to the front rail of the sofa, so that said under seat, by letting the ordinary seat back, can be turned out of the front of and on a level with the ordinary seat, thus forming a bed.

I also claim the arrangement of hinging the stuffed back to the top rail of the sofa, and attaching the back at the bottom to the top seat, by strips of iron, in combination with the arrangement of hinging the top seat at the back lower corner.

William Crighton, of Fall River, Mass., for Shuttle Motions for Power Looms.

Claim.—I do not claim operating the picker by a cam or short shaft, at the side of the loom, but I claim connecting the two pickers with a rod or rigid connection, which receives motion from a single lever, and one cam, whereby both pickers are operated, as set forth.

H. S. Crider & David Williams, of Lancaster, Ohio, for Attaching artificial Teeth to the Metallic Plate.

Claim.—Securing the artificial teeth to a plate, by the usual method, and afterwards fastening said plate on the alveolar ridge of the plate, having the impression of the mouth, either by riveting or the employment of soft solder, so as to prevent the application to the plate having the impression, or the intense heat required to secure the teeth, as and for the purpose set forth.

Charles Flanders, of Boston, Mass., for Steering Apparatus.

Claim.—The combination and arrangement of the rope, the two sets of leading blocks, the sheaves in the after end of the tiller with one another, the tiller and windlass, so as to operate together and move the rudder, as specified.

James J. Clark, of Philadelphia, Pa., for Improvement in Self-winding Telegraph Registers.

Claim.—The combination of the winding magnet, the break circuit wheel with the train of the wheels of an ordinary telegraph register, in the manner described.

Benjamin Frazee, of Durhamville, N. Y., for operating Mill Saws.

Claim.—Attaching a reciprocating saw blade to the main shaft, by means of a slotted lever and crank pin, operating as set forth.

Robert Griffith, of Newport, Ky., and George Shield, of Cincinnati, Ohio, for Machine for making Railroad Chairs.

Claim.—First, hanging the fulcra of the clipping and bending levers eccentrically, in boxes made capable of circular movement, for the purpose of adjusting the said levers to their work with facility and accuracy, as specified.

Second, the method described of adjusting the angular set of the clipping and bending levers, by pivoting, and adjustably connecting them to outer operative levers, as set forth, and whereby a varied inclination may be given to the cutting and bending of the clip, to suit different thicknesses of blanks or forms of chairs required.

G. W. Griswold, of Carbondale, Pa., for Implements for Cutting Cloth.

Claim.—Stretching the cloth or other material to be cut, over the two jaws of the stock, and holding it firmly in place by the clamp, whilst the knife divides it with a draw-cut, as described.

Thomas Hinkley, of Hallowell, Me., for Instruments for Plotting.

Claim.—The method or means of obtaining in the machine described, a compound or resultant parallel motion, the same consisting in a combination of pinions, or gears, or sunken racks (or racks provided with parallel bars), as specified, two sliding and rotary shafts, as arranged, connected, and supported so as to operate together, as described.

Daniel Lynahon, of Buffalo, N. Y., for Cutting Boots.

Claim.—The tongue which first gives to the vamp a more exact crimped turn; secondly, covers the seam from being seen, and prevents it from ripping; and, thirdly, keeps the seams permanent by receiving the strain that comes on them when drawing on the boot.

Wm. Mason, of Taunton, Mass., for Power Looms.

Claim.—The method of operating the warp beam to let off the warps, and ease them in the opening of the shed, by means of the weighted cord acting on the periphery of a wheel geared to the warp beam, and receiving motion from an eccentric, or its equivalent, as specified, in combination with the mode of regulating the delivery motion, by the action of the warps on a weighted whip roller, acting by a friction strap on the friction wheel of the let-off apparatus, as specified.

N. Millington & D. J. George, of Shaftsbury, Vt., for Machines for figuring Carpenters' Squares.

Claim.—The combination of the revolving chase wheel, with the lateral moving anvil, by which the relative position of the square to be stamped, and the required chase, is so regulated that the line of the square to receive the impression is brought under the chase, containing the desired figures, as set forth.

John Pender, of Worcester, Mass., for Power Looms.

Claim.—The rest, in combination with the guides, when constructed, as described.

B. F. Rice, of Clinton, Mass., for Looms for weaving Fancy Goods.

Claim.—The application of compound levers constructed as described, to raising and depressing of harnesses and heddles, as set forth.

I also claim employing a finger attached to the vibrating lever, operating as described, in combination with the crown wheel, to move the figuring chain, as specified.

I also claim forming a groove in the bars of the figuring chain for the insertion of hooks or pins, or their equivalents, as specified.

John Scott, of Philadelphia, Pennsylvania, for Air Beds.

Claim.—Forming a bed of an air-tight India rubber cloth sack, inclosed or enveloped in a pouch-formed mattress, composed of two thicknesses of ticking or other suitable material, between which is interposed feathers, hair, cotton, or other soft substance, retained by properly quilting said mattress, conforming to the shape and size of the air sack, when extended with air by flexible pipes.

Nathan Thompson, Jr., of Williamsburgh, New York, for Life-preserving Bucket.

I do not claim a double vessel, as such have been employed both as refrigerators and as retainers of heat.

Claim.—First, a double vessel, the space between the outer and inner side thereof being filled with cork, or its equivalent, by which it is in a great measure secured against leakage, and retains sufficient buoyancy when punctured, and serves as a reliable bucket and life-preserver.

Second, I claim attaching the handle thereto, by means of the tubes, the nicks in the handle, and the bending of the ends of the tubes therein, as described.

Nathan Thompson, Jr., of Williamsburgh, New-York, for Life-preserving Seat.

I do not claim a life-preserving stool or seat in general.

Claim.—First, the folding life-preserving seat with a buoyant divided top, constructed as described.

Second, the clasp, in combination with the surfaces on which it slides, constructed substantially as described, and operating to hold the stool either shut or open, as described.

Thos. E. Warren, of Troy, N. Y., for Iron Car Bodies.

Claim.—The combination of the hollow sheet metal columns and panels, as described, with the through bolts, holding the top, bottom, and sides all firmly together, as set forth.

J. W. Weatherby, of Kingsville, Ohio, for Carpet Stretchers.

Claim.—I do not claim the invention of rack and wheel, or any of these parts separately of themselves, but the general construction and arrangement, to save much time and labor. I therefore claim the general construction and arrangement of the carpet-stretcher, made and operated, as described.

Linus Yale, of Newport, N. Y., for Door Locks.

Claim.—Introducing and applying the key from behind instead of in front, as is usual, by means of a permanent wrench-revolving key chamber and the passage, in the manner described.

Harry Whitaker, of Buffalo, N. Y., for application of High-Pressure Engines to Screw Propellers.

Claim.—The direct application of the crank outside of the hull to side-screw propellers, when such application is combined with or effected by a high-pressure engine, arranged also outside of the hull, as set forth.

Calvin Adams, of Pittsburgh, Pa., for Window Shutter, Fastener, and Holder.

I do not claim the construction of the shutter fastening, nor the use of the latch and pin, as used for fastening shutters when closed, nor otherwise than in combination with the contrivance for bowing shutters.

Claim.—Combining with the latch or bolt of an inside shutter fastener, a contrivance for securing the shutters in a partially opened position, by means of the rings and arm, in combination with the latch and pin, substantially as set forth.

G. T. Beauregard, of New Orleans, La., for Self-Acting Bar Excavators.

Claim.—The bar excavator in which the surface current, by means of the inclined plane, is deflected downward, and made to act upon the bar, the whole being arranged and operated as described.

Ezra B. Dewes, of Litchfields, Me., for Devices of a Convertible Dung Fork.

Claim.—Making the tines of ordinary dung or hay forks to revolve upon the handle, as set forth.

F. P. Dimpfel, of Philadelphia, Pa., for propelling Vessels.

Claim.—The arrangement of the water passages, apertures, and valves, in combination with a reciprocating piston and its chamber, substantially as set forth.

Augustus Eliaers, of Boston, Mass., for Lounges.

Claim.—The parts which form the support to the upper part of the body in lounges, or other similar articles of furniture, upon springs and hinges, as described, so as to vary its inclination at the pleasure of the occupant, the said support being fastened and held in any desirable position by a set screw and curved arm, as set forth.

Augustus Eliners, of Boston, Mass., for Library Step Chairs.

Claim.—A library step chair, or a chair which may be changed at pleasure into a flight of steps, in which the fold or hinge of the two parts is formed in the top, or an extension of the front leg of the chair, hereby permitting the seat to be so stuffed as to form an ornamental and comfortable chair, and when opened, to form a flight of five steps, as set forth.

Wooster A. Flanders, of Sharon, Vt., for Bee Hives.

Claim.—I do not confine myself to the peculiar construction described, but I claim the adjustable passage by which the entrance to the hive may be enlarged or diminished, in the manner set forth.

John D. Filkins & W. H. Du Puy, of Lima, Ind., for attaching Horses to Ploughs.

Claim.—The combination of the limber and stiff tongues with the running gear, to adapt it to being drawn by two teams abreast, as described.

Samuel Hutchinson, of Rockport, Ind., for Cutting and Planting Potatoes.

Claim.—The construction and combination described, of the cam, sliding platform, cutting blade, and trap doors, with the furrowing share and covering blade, for cutting, dropping, distancing, and covering potatoes.

David S. Mackey & J. R. Smith, of Batavia, N. Y., for Winnowers.

Claim.—First, the peculiar manner of operating the screen, viz., by means of the eccentrics placed in a reverse manner upon the shaft, said eccentrics working between the blocks attached to the under side of the screen, as described.

Second, we claim producing two blasts upon a single fan, and having the two blasts cross or intersect each other, by which a blast passes horizontally over the top of the screen, and a blast also passes upward through the screen, preventing the screen from being clogged or choked by the chaff.

E. G. Matthews, of Troy, N. Y., for Machines for dressing Stone.

Claim.—The driving apparatus for driving the cutters, said apparatus being formed or constructed of the driving wheel and friction wheel, arranged as specified, in the frame attached to the driving rod, by means of which rod a reciprocating motion is given to the said frame, which causes the driving wheel to roll back and forth, on and over the heads of the cutter stocks, thereby causing the cutters to make the desired cut in the stone, the friction wheel meanwhile rolling on the periphery of the driving wheel, and also in a groove in the cross-bar, as described. I do not intend to confine or limit myself in this claim, exclusively to the use of one friction wheel, but hold myself at liberty to use one or more, and to vary the arrangement of them, while the principle of driving the cutters, as described, is substantially adhered to.

Second, I claim the rocking bar, with inclined planes at each end, in combination with the cutter stocks, and the roller or its mechanical equivalent attached to the frame of the driving apparatus, for the purpose of rolling or striking on the inclined planes of the bar, as the driving apparatus reaches the end of its stroke, so as to rock or tip the bar, thereby causing the inner edge of the bar to catch or stroke under the shoulders of the cutter stocks, and raise them up in position for the driving wheel to act upon them in its return stroke, substantially as specified.

Charles Perley, of New-York City, for Ships' Side Lights.

I do not claim sliding a glass or light sideways in a frame, as that has been done, but I am not aware that any box has been so fitted as to contain a side light, and form a receptacle for leakage, passing the same out by a small hole or holes, thereby effectually preventing any water from passing into the ship.

I am aware that India rubber has been used as a packing for side lights, therefore I do not claim the same.

Claim.—The means described for preventing any leakage from a side light passing into a vessel, by inclosing the side light in a metallic box, let into the side of the vessel, and provided with a small hole or holes to pass out said leakage, as specified.

Alphonse Quantin, of Philadelphia, Pa., for Valve-Gauge for Bottles.

Claim.—The machine or gauge, with the arrangement of the valves, as described, one opening by the act of closing the other, so as to pour out of the vessel to which the gauge is attached only the quantity of liquid contained in the space between the two valves.

H. L. Russell, of Hudson, Mich., for Metallic Piston Packing.

I do not claim the metallic bands, for they are now used in metallic packing.

Claim.—Expanding the metallic bands which encompass the drum, by means of the levers placed in the periphery of the drums, and operated by means of the ring, within the drum, as described, the ring being prevented from moving casually by means of the coil-spring ratchet, and pawl, or their equivalents.

William W. Richards, of Philadelphia, Pa., for making Shovels, Spades, &c.

Claim.—A new manufacture of shovels, spades, and other implements, made of a composite sheet of metal, whose constituents are parallel laminæ of unequal hardness, as set forth.

But I make no claims to such implements made of the hard lamina extending to a short distance only above the edge, but only where it extends up beneath the strap to support the back.

B. P. Sergent, of Sutton, N. H., for Expanding Horse Shoes.

Claim.—The combination of the bearers or ears, with the jointed quarters or bars, jointed together, or to a common toe-piece or cork, and operated by an expansion screw or contrivance, as specified.

J. T. Sargent, of Sutton, N. H., for Garden and other Hoes.

I do not claim the employment of a screw and nut for confining two things together; nor do I claim the attachment of the shank and blade of a hoe, by means of the bearing plates welded to and forming part of the shank, and riveted to the blade.

Claim.—Attachment of the blade and shank, whereby the blade not only can be readily removed from, or as readily confined to the shank, but when affixed to it, is prevented from breakage, where the greatest leverage or strain is brought upon it, meaning to claim the bearing head fixed firmly to and making part of the shank, the movable plate or stiffener, or its equivalents (applied to the back of the plate, and made separate from the shank), the screw on the shank, the screw nut, and the recess in the hoe blade, as combined together, and with the shank of the handle, and made to operate, as specified.

D. M. Smith, of Springfield, Vt., for Spring Clamps for Clothes Lines.

I do not claim a mere clasp composed of two levers, hinged together between their respective ends, and having a spring placed between their two adjacent arms.

Claim.—The described improved clothes pin, that is to say, I claim the arrangement of the line opening, and the spring, on opposite sides of the hinge of the two levers, all as specified, whereby by pressure of the longer legs of the levers between the thumb and fingers of the hand of a person, the instrument is rendered very convenient of application without danger, during the same, of tearing the clothes secured by it on a line.

James Trees, of Salem, Pa., for Propellers.

Claim.—The combination with submerged propellers, whose area where the water enters is greater than the hinder extremity where the water escapes, of helical blades or vanes, and a tapering shaft to which they are attached, both the blades and shafts tapering from point to rear, as set forth.

Albert Vose, of Pittsfield, Vt., for Ox Yokes. Antedated Aug. 10, 1853.

Claim.—First, the construction of the semi-revolving neck blocks, each having a curved groove and pin fitting into it, for enabling the neck block to always adjust itself at right angles to the direction of the neck of the animal.

Second, I claim, in combination with the groove in the neck block, the use of the pin subserving the double purpose of controlling the movement of the neck block, and adjusting the length of the yoke, as described.

Wm. Wheeler, of West Poultney, Vt. (assignor to Charles H. Kellogg, of Troy, N. Y.), for cutting the Bars and Teeth in Curry Combs.

Claim.—The method of forming the bars of curry combs, by punching them out of plates, so that at a single operation a strip of the proper width for the bar is severed from the plate, and one row of teeth cut thereon, and another row upon the end of the plate for the next bar, as set forth.

Wm. Coughlan, of Baltimore, Md., for Soda Fountains.

Claim.—The auxiliary faucet or valve, for the the purpose of enabling the fountain to be filled with prepared mineral water, as described.

Nelson Crocker, of Sandwich, Mass., for attaching the Head Cringle to the Yards of Vessels.

Claim.—The head cringle hooks and their fixtures, constructed and combined with the rigging of a vessel, as set forth.

N. C. Davis, of West Jefferson, Ohio, for Seed Planters.

Claim.—The piston provided with a notch or hollow, in its upper end, and so arranged in combination with the partition and depression, that it will bring up and discharge through the aperture, the desired number of grains of corn every time it is raised by the operator, as set forth.

Daniel Noyes, of Abington, Mass., for Machine Hammers.

Claim.—First, a machine for hammering iron, &c., having the distinguishing features enumerated, viz., a hammer for giving the blow upon the upper surface of the iron acting in conjunction with two hammers, which simultaneously strike the sides of the iron, as set forth.

I further claim, in a machine for hammering iron, the use of these two side hammers operating as specified, whether used in connection with the upper hammer or without it.

Second, I claim so arranging the relative position of the fulcra of the hammer beam, and the ends of the connecting rods attached to said beams, and to the crank shaft and gears, from which they derive their motion, as to bring the said fulcra and connecting rods in nearly a straight line at the time of giving the blow, for the purpose specified, the opposite ends of the connecting rods, just before giving the blow, moving in opposite directions, so as to give a rapid and powerful blow.

Third, I claim causing the anvil to descend from the iron just before the blow of the side hammers, and to ascend just before the blow of the upper hammer, by means of a rod attached at one end to the under side of the upper hammer beam, and at the other end to a tilting arm, which embraces the anvil, as described.

Samuel Pratt, of Boston, Mass., for Screw Nails.

Claim.—A screw nail constructed with a thread shaped as described.

I also claim shaping the head as set forth, so that the battering caused by the driving will not obstruct the application of the turn-screw.

Samuel Sweet, of New-York City, for Spark Arresters.

I make no claim to originality of invention in the individual parts of the spark arrester, separately considered.

Claim.—The combination of the reticulated inverted frustums of cones, constructed and situated as described, with the trumpet-shaped reflector and guard, the reticulated cylinder under the opening provided with the reticulated valve, when these parts are arranged in the upper portion of an enlarged or external pipe, the whole operating as set forth.

Kasimir Vogel, of Chelsea, Mass., for Looms for making Weavers' Harness.

Claim.—I do not confine myself to the precise details set forth, but I claim the combination of the loom for weaving the borders of the harness, with the press for securing the metallic eye upon the threads of the harness without a knot, braid, or loop, as described.

William Ballard, of New-York City, for protecting bulwarks for War Vessels.

Claim.—The use of the shield boards, in combination with the bulwarks of a ship, as set forth.

I also claim the use of the stanchions and panels, in combination with the deck of the vessel, and the shield-board, for the principle of construction and operation as set forth.

Calvin Carpenter, Jr., of Pawtucket, Mass., for Magneto-Electric Machines. Patented in France April 18, 1858.

I do not claim the employment of permanent magnets of helical coils of wire of metallic segments upon a cylinder of non-conducting material, or of springs such as I have described, either separately or in combination, for the purpose set forth, otherwise than in the manner in which I have arranged, connected, and combined them.

Claim.—The combination of one or more series of permanent magnets radially arranged, the poles of each series being in one plane, and in two concentric circles, with a disc or discs of helices, arranged in three sets in such manner, that the three sets may be acted upon successively, at nearly equal intervals of time, one set by the inner circle of poles, and the other two sets by the outer circle of poles; the currents of the several sets of helices being thrown into one constant or uninterrupted current, by means of the current discharges and springs, or their equivalents, as described.

A. P. Chatham, of Canoga, N. Y., for Car Couplings.

Claim.—Constructing the buffer A, with a recess to hold the link in the proper position for entering the buffer B, and the buffer B, with a cavity and an inclined draught catch extending to nearly the top of its cavity, so that when a link is connected to the buffer A, and passed over the catch of the buffer B, it cannot jump up and become detached from the catch while the cars are in motion, whereby the danger of the cars being separated while running is greatly lessened, while the coupling is simple, cheap, and not liable to get out of order.

G. S. Clark, of New-York City, for Pen and Pencil Case.

Claim.—I claim neither the pen or pencil slide separately, for both have been previously used; but I claim the peculiar arrangement of the pen and pencil slides, as described, viz., having the pencil slide with its covering tube placed within the pen slide or the tubes C and D, operating the two slides independently of each other, in the manner set forth.

John W. Cormack, of Quincy, Ill., for Cane and Maize Cutters.

Claim.—The framing and maner of attaching the knife and arm to the sled.

Benjamin Crawford, of Pittsburg, Pa., for Condensers for Steam-Engines.

Claim.—The arrangement of the tubes or passages in the condenser, with the inlet and outlet openings in the case, as specified, so that a current of water is caused to flow round both ends of the tubes, whereby the condenser is prevented from undue heating, and the tubes kept coolest at both ends, and warmest at the middle, whereby the great bulk of the heat is transferred to the condensing water, near the point at which it is discharged from the case.

Second, constructing the case of the condenser with stuffed or other equivalent joints, to render it flexible, and thereby prevent fracture.

C. O. Crosby, of New Haven, Conn., for Machine for sticking Pins.

I am aware that conical rollers have been used for forming the inclined channel for conducting the pins, and that a screw has been used for separating the pins, and that pliers have been used in the manufacture of pins, and that clamping bars have been used for clamping the paper, and it has been crimped, and that the paper has been drawn through and rolled up by a revolving cylinder, so graduated as to regulate the quantity of paper, as to folding up. I therefore do not claim either of these as such.

Claim.—The method of crimping the paper by means of movable folding blades in combination with the bed plate, while the back and front sides of the paper are sustained by the clamping bars, as described.

Second, I also claim the method of crimping the paper by means of moving folding blades descending and ascending between the stationary and moving clamping bars, when the clamping bars serve as a part of the crimping apparatus, whether the paper be sustained by a bed plate or otherwise, when constructed and operating as described.

Third, I also claim the method of lifting the pins from the distributor, and carrying them away, and sticking them into the crimped paper, while the distributor is bringing another supply of pins in front of the clamping bars, thereby keeping the lifting pliers or other lifting apparatus continually in operation, when performed by the means and in the manner described.

Fourth, I also claim the lifting apparatus, or any substantial part thereof, when constructed, combined, and made to operate as described.

Fifth, I also claim the combination of the lifting apparatus described, with the inclined transverse notches in the stationary clamping bar, by which means the pins will always be stuck in an exact line, even though the pins are not straight, when constructed, combined, and made to operate, as described.

Sixth, I also claim the combination of the conical rollers, with the side planes, to form a straight inclined conducting channel, when combined, constructed, and made to operate as described.

Seventh, I also claim the lifting pliers, when constructed and made to operate, as described, either with or without the creeper, sliding guide, or director.

C. O. Crosby, of New Haven, Conn., for Machines for sticking Pins.

I do not claim the channels nor grooves, nor the punches working in the grooves, nor the use of clamping bars, to serve also as crimping bars, because these have all been used before, or claimed in my former applications.

Claim.—The combination of the punches working in horizontal grooves, with the slide and the straight inclined channels, when arranged as set forth.

I also claim the combination of the punches, with the double folding blades, when these are combined with the movable and stationary clamping bars, constructed as described.

I also claim the method of crimping the paper by means of folding blades working between the stationary and moving clamping bars, when those clamping bars serve as a part of the crimping apparatus, when constructed and operating as described.

I also claim the bars (forming the side guides to the spaces) to guide the pins while falling down from the separator to the horizontal grooves, in combination with the grooves and punches, when they are constructed and arranged as set forth.

C. O. Crosby, of New Haven, Conn., for Machines for sticking Pins.

Claim.—The use of the slide wheel, to connect the lower end of the straight inclined conducting channel with the upper end of the vertical side guides, to convey the pins from the former to the latter, while it changes the position of the pins from vertical to horizontal, as described, whether with or without the counter-sinks in the inner edge of the peripheries.

I also claim the use of a separating wheel with teeth on its periphery, to sustain the column of pins, separate them, and drop them separately into the grooves in the sliding bed, at the proper time by its revolution, as described, whether the wheel be made of two discs, or with the periphery grooved out, or the periphery be single, and the teeth cut directly across it.

I also claim the method of crimping the paper, by the use of jaws, with a tongue between them, to slide across the paper in such a manner that the paper may be crimped by double folding blades, forcing the two folds of paper through the space between the tongue and the jaw on each side, so that the pins may be stuck through the crimps over the open edges of the folding blades, while the tongue will be between the pins and the paper, and so that both the bars and tongue, and the double folding blades, may be readily withdrawn to release the paper, and this, whether the double folding blades are above or below the jaws and tongue, when they are constructed, used, and made to operate as described.

David Demarest, of New York City, for Hose Protectors.

Claim.—The employment of a portable section of a rail track, constructed as described, and with an opening in its centre for the hose to fit in, when said section is placed over said hose, the same being employed in the manner described, and for the purpose of covering the hose at certain points, and saving them from the great injury they sustain from carriages and cars passing over them during the time of fires, and as fully set forth.

Joseph Farnsworth, Jr., of Madison, Ind., for Car Wheels.

Claim.—I am aware that P. W. Gates made a cast iron car wheel, in which the rim is connected to the central parts by two sets of short spokes, but this (without admitting its priority to my invention) I do not claim, as my improvement relates exclusively to that class of wheels in which a disc extends from the hub to the rim, my object being to support the rim and strengthen the disc by flexible supports, which will perform their duty without straining and endangering the breaking of the disc, as in the case of the wheels of this class.

I claim a cast iron car wheel, constructed as described, but I make no claim to any part of the wheel by itself, nor to any other combination of parts than those set forth.

Luther R. Faught, of Macon, Ga., for regulating the Speed of Steam-Engines.

I do not confine myself to the employment of a pendulum or air-spring, as there may be other devices that would produce analogous effects; neither do I confine myself to the precise methods of producing friction described, as both the methods that I have shown are well known, viz., by the pressure of the steam in the valve chest, and by plates compressed to the rod by a spring; nor do I confine myself to the adjustment of the relation between the pendulum, and the device or devices which produce the friction, as it will be evident that the lengthening or shortening of the pendulum will produce the same effect.

Claim.—Connecting the cut-off with the slide valve, so that the latter drives the former by friction, when the cut-off is at the same time connected with a pendulum air-spring, or some other device, offering such a resistance to its movement, as will prevent its moving the same distance as the valve, and arrest it at such a point in the motion of the valve, as to cut off the steam at the desired point in the stroke, and will increase or diminish with any increase or diminution of the speed of the engine, and thereby retard the motion of the cut-off, more or less, in order to cut off the steam earlier or later in the stroke, and thus regulate the speed as described.

C. P. Kelsey, of Livingstonville, N. Y., for Grain Cradles.

Claim.—First, the bar or its equivalent, for attaching the fingers of the frame to the snaith, for the purpose set forth.

Second, I claim so connecting the braces with the fingers, by means of links or universal joints, that the snaith may be folded close against the fingers, without requiring that the said braces should be loosened in the snaith, as set forth.

Edmund Morewood & George Rogers, of London, England, for coating Sheets of Metal.

Claim.—The method described of coating sheets of metal by immersing them in other molten metals, which are more fusible, by means of rollers, arranged as described, so that with the same machine, sheets of metal, varying in thickness, may be coated free from puckers, bends, or indententions on their surfaces, thus rendering unnecessary the subsequent operation of flattening, which heretofore could not be dispensed with.

R. S. Morse, of Dixfield, Me., for Adjustable Springs for Carriages.

Claim.—The adjustable auxiliary springs, in combination with the bed spring or springs, as set forth.

Howard Perkins, of North Bridgewater, Mass., for Brace and Bit Fasteners.

Claim.—The manner of constructing and fastening the bit into the socket by the slide lock, as described, having the end of the bit so formed as to fit into the groove in the key, as set forth, and having the end of the bit pressed down upon the key, so that when the key is slipped back, the bit may be easily removed.

Henry M Ritterband, of New-York City, for Gold Washers.

Claim.—The combination of the tube, valve, and lip, constructed and having the regular proportions, as described, forming an apparatus for removing earth and stones from auriferous earth, as specified.

John A. Taplin, of Fishkill, N. Y., for Straw and Grain Separators.

Claim.—The vibrating straw carrier and grain separator, constructed as set forth, with a screen and fluted bottom board, for the purpose of separating the grain from the straw, returning the former to the winnowing apparatus, and conveying the straw to the binder extremity of the machine.

Wm. H. Towers, of Philadelphia, Pa., for Metallic Pens.

Claim.—Making metallic pens with depressions or cavities for retaining the requisite quantity of ink to supply the same, and making them flat on both surfaces, and tapering the shank or main body of the same, and inserting it in a corresponding socket or opening in the centre or lower end of the holder, in the manner set forth.

Increase S. White, of Hubbardston, Mass., for Machine for turning Cylinders of Wood.

Claim.—The combination composed of the feeding hopper, the series of rotary mandrels and centres, applied to the shaft, the revolving cutter or cutter cylinder, the mechanism for giving to each mandrel an endwise movement backward and forward, as described, mechanism for arresting the rotary movement of the shaft, or the heads, during the time necessary for the operation of the cutter or cutter wheel, on each piece of wood, and finally a mechanism for rotating the shaft and its two heads, all as described; the mechanism for moving each mandrel endwise, as described, being the spring, the wheel, and cam plate, as described; that for rotating the mandrel being the gear, and the gear on the shaft put in revolution as described; that for arresting the rotation of the shaft during the time necessary to turn down an article, being the stud or stop plate, and the screw applied to each mandrel, and made to operate as specified; and, finally, that for rotating the shaft, being the friction roller made to operate against the periphery of the circular head, and to be rotated and borne against said head, as set forth.

Peter H. Watson, of Washington, D. C., for Generating and Condensing Steam. Antedated May 2, 1853.

Claim.—The method of recovering the heat of the exhaust steam, by passing it through the comparatively cool water in the lower portion of the boiler, as set forth.

I also claim the arrangement of the upper end of the drop flues, in an inclined plate, to facilitate the entrance of the smoke into the flues, and the passage of the steam from beneath the inclined plate into the upper part of the boiler, as set forth.

J. V. A. Wemple, of Chicago, Ill., for Grain Separators.

Claim.—The employment of a cylinder, having tangential or other suitably projecting plates across or along its periphery, for the purpose of separating the grain, and breaking the impinging effect produced by the threshing cylinder on the endless apron, the said cylinder being so situated, and operating in rear of the threshing cylinder, as gently to feed over it the straw and headings, as they are delivered from the threshing cylinder.

Geo. Calvert, of Upperville, Va., for Bee Hive.

Claim.—The combination of the honey boxes with another box and cross-pieces, arranged and operated in the manner as set forth.

Seneca Lapham, of Salem, Ohio, for Devices for steering Cultivators.

Claim.—The combination and arrangement of the parts, consisting of the lever and its attachment to the brace, and the connection of the tongue to the lever by the staple. This I claim in its application to the purpose of changing the direction of this and the other machines, as specified.

Wm. B. Leonard, of New-York City, for Fluid Meters.

Claim.—The combination in fluid meters of mechanism for measuring the volume of a flowing fluid however variable; mechanism for measuring the velocity of the flowing fluid, however that may vary; mechanism for multiplying these two quantities together, and mechanism for recording the product, in such manner as to show on a register the quantity of fluid that has passed, as set forth.

I also claim the combination of a self-acting guard valve or valves, however constructed or arranged, with the water wheel or other motor, in a meter, in such manner that the flow of water through the meter will be arrested, whenever its pressure is not sufficient to give motion to the motor the instant it begins, whereby the escape of water through the meter, unmeasured, is prevented.

William T. Merritt, of Hart's Village, N. Y., for opening and closing Gates.

Claim.—Elevating or depressing, or opening and closing the gate, as described, viz., by means of the shaft, having upon it the pulley F, the pulleys G G being attached permanently to said shaft, and having ropes attached to them; and the pulleys F F being placed loosely on the shaft, and connected to it at a certain period by means of pins on the shaft working in slots in the bosses or hubs of the pulleys, said pulleys having the chains attached to them, and to the upper ends of the gate stiles, and also to the chains I I, with the weights, the chains I I being attached to the lower ends of the stiles, the gate being prevented from being casually depressed by means of the pawl, which is freed from the notch in the boss or hub by the dog, substantially as set forth.

George Williston, of Brunswick, Me., for straightening and curving Rails.

I am aware that a machine has been used in Bavaria, which acts by the pressure of a screw upon the bar to be bent, the bearing or platform being placed underneath the bar. This I do not claim.

Claim.—The combination of the screw, strap beam, and slides, constructed as described, with the beam placed on the top or side of the rail, for the purpose of straightening or curving rails on railroads, without the necessity of removing the same from the sleepers.

DESIGNS.

T. G. Gilles, of Williamsburgh, N. Y., for Metallic Coffins.

N. Putnam Richardson, of Portland, Me., for Cooking Stoves.

Winslow Ames, of Nashua, N. H. (assignor to Hartshorn, Ames & Co., of Boston, Mass.), for Parlor Stove.

J. A. Read, of Philadelphia, Pa. (assignor to Wm. W. & Charles M. Atkins), for Register.

Mechanics for Practical Men.—Strength of Wood.—Practical Formulæ.

No. 5.

The absolute strengths of all the different kinds of wood used in constructions, will be found in the table of "Strengths of Materials," in the first of this series.

As to the limit of elasticity of wood, the following table, from the experiments of Haupt, on American wood, will give some idea, and, moreover, will show the relative value of the different species.

Those pieces marked "Injured" are those in which the limit was just exceeded.

Kinds of Timber.	Strain per sq. in. in lbs.	Remarks.	Time.
White pine, - -	2273	Injured,	10 minutes.
Do., - - - -	1548	"	16 days.
Hemlock, - - - -	2674	"	5 minutes.
Do., - - - -	1620	"	16 days.
Yellow pine, - - -	2848	"	5 minutes.
Do., - - - -	1840	"	16 days.
Locust, - - - -	6004	Not injured,	2 minutes.
Do., - - - -	3600	Injured,	8 1·2 days.
Do. - - - -	2304	"	16 do.
White oak, - - - -	4248	Not injured,	15 minutes.
Do., - - - -	7200	Injured,	do.
Do., - - - -	3648	Not injured,	40 hours.
Do., - - - -	4088	Injured,	48 do.

Resistance to a transverse strain.—This is a subject of considerable importance, as timber is more often used to resist this strain than any other, and will be discussed more at length under the head of Practical Formulæ.

The following table, from Professor Mahan's work, gives, in a convenient form, the constants for flexure and fracture, but it must be remembered, only for the ultimate strength.

Let l = Distance between supports in inches,
" b = Breadth of the bar in inches,
" d = Depth " " "
" f = Deflection from a weight w in inches,
" W = Weight necessary to break the bar in lbs.

Description of Wood.	Values of l.	Values of b.	Values of d.	Values of f.	Values of w.	Values of W.
Oak (English), - - -	84	2	2	1·280	200	637
Do. (Canadian), - -	84	2	2	1·080	225	673
Pine (American), - -	84	2	2	0·931	150	—
Oak (English), - - -	30	1	1	0·5	137	—
White spruce (Canadian),	24	1	1	0·6	180	285
White pine (American), -	65·2	2·75	5·55	0·177	777	5189
Black spruce (do.), - -	85·2	2·75	5·55	0·177	602	5646
Southern pine (do.), - -	85·2	2·75	5·54	0·177	1175	9237

• The weight in these experiments was applied at the middle of the bar.

Resistance to detrusion.—This is the resistance exerted to a force acting parallel to the fibres, tending to overcome their lateral adhesion. Professor Barlow states it for fir at 600 lbs. per square inch; beech is 1550. Tredgold states the resistance offered to a force acting at right angles to the fibres to be, for oak, 2816 lbs. per square inch, and for larch from 1000 to 1700.

PRACTICAL FORMULÆ.

The following is intended to be precisely what its heading states—that is, a series of practical rules for the use of the practical engineer and mechanic, and sufficiently full to apply to most cases of ordinary construction.

It is lamentably well known that practical men are apt to have little confidence in these things, preferring to trust to their own experience, and having little opinion of scientific men; and it must be admitted that they have not this prejudice without reason. The merely theoretical man, although his deductions are mathematically correct, according to his data, neglects too much to take account of the accidents and emergencies which arise in practice, imperfections of materials, &c. The laws and absolute data furnished by him, are, of course, correct; but when he comes to give advice as to applying them in practice, he only exhibits a want of practical knowledge, and lays down rules that appear ridiculous to the man of experience. It is this that has induced such a mistrust, aided also by the fact, that men unacquainted with all the hidden depths of science, do not see the power that resides there, and, therefore, refuse to recognize it. All matter and motion is governed by certain fixed laws, which it is the business of the scientific man to investigate, and the only difficulty that arises is the application of these laws to cases of every day construction. This can only be done by men who combine theory and practice; men who, in addition to a thorough acquaintance with science, have also that practical experience, without which the first is useless.

It is known that there are men of this class, whose authority may be depended upon; and it is the object of this series to give the precepts and rules laid down by the most eminent men—rules that have been proved in practice, and are in every day use by the most eminent engineers and constructors.

Solids submitted to a transverse strain.—Call R the maximum amount of strain, either of compression or of extension, to which a square inch of the solid may be submitted without fear of injuring its elasticity.

A the moment of inertia of the transverse section of the body at the point of rupture, taken with reference to the line of fibres, whose lengths are invariable.

V the greatest ordinate of the exterior surface, or the distance of the fibre the farthest from the line of invariable fibres, either above or below.

The product $\frac{RA}{V}$ will represent the sum of the moments of the resistance to rupture, of all the fibres of the section of rupture; and this moment should be equal that of the force tending to break the body taken with reference to the same section.

The following are the values for R:

For cast iron R = . . . 12,500
" Wrought iron " = . . . 10,000
" Oak or pine, " = . . . 1,000
" Steel " = . . . 20,000

The value of R depends on the destination of the piece under consideration, and cannot be fixed upon until after the circumstances are known. The examples given are the only guides that can be furnished here.

Solid, fastened at one end, with the force applied at the other.—In the following formulæ, call

P, the force acting at right angles to the length of the body.

C, the length of the body, from the point of support to the point of application of P.

p, weight of one foot in length of the solid.

a, width of the solid, perpendicular to the plane passing through the axis, and the line of direction of the force P.

b, depth of the solid in the direction of the force P.

d, diameter of the solid in case it is cylindrical.

The weights are expressed in pounds and the dimensions in feet. In case of a solid, fastened at one end and with a force applied at the other, tending to break it transversely, the relation between the acting force and the dimensions is expressed in the following equations:

For cast iron, . . . $ab^2 = \dfrac{\left(P+\frac{pC}{2}\right)C}{256000.}$

" Wrought do., . . $ab^2 = \dfrac{\left(P+\frac{pC}{2}\right)C}{205000.}$

" Oak or pine, . . $ab^2 = \dfrac{\left(P+\frac{pC}{2}\right)C}{20500.}$

The above takes into account the weight of the solid; where this is neglected, they become,

For cast iron, . . . $ab^2 = \dfrac{PC}{256000.}$

" Wrought do., . . $ab^2 = \dfrac{PC}{\cdot 205000}$

" Oak or pine, . . . $ab^2 = \dfrac{PC}{205000.}$

Where the weight is distributed uniformly over the length of the piece, add the charge per running foot to the weight of the piece per running foot; calling this p, we have the following equations:

For cast iron, . . . $ab^2 = \dfrac{pC^2}{1677500.}$

" Wrought do., . . $ab^2 = \dfrac{pC^2}{1342000.}$

" Oak or pine, . . $ab^2 = \dfrac{pC^2}{13420.}$

The relations between a and b are generally established in the first place, when calculating the cross section necessary to bear a given weight, acting at a certain distance, as for instance, in wood, a generally equals 5-7 b.

Let k be the ratio of a to b, that is, let $a = kb$. In this case, the equations in which the weight of the piece is not taken into account, will become

$$\left.\begin{array}{lr} \text{For cast iron,} \quad . \quad . \quad . & b^3 = \dfrac{PC}{256000 \cdot k} \\ \text{" Wrought do.,} \quad . \quad . & b^3 = \dfrac{PC}{205000 \cdot k} \\ \text{" Oak or pine,} \quad . \quad . & b^3 = \dfrac{PC}{20500 \cdot k} \end{array}\right\} \text{A.}$$

Example.—What should be the height and depth of a piece of wood, fastened at one end, and which is to bear a weight of 1500 lbs. at the other, applied at 5 feet from the point of support?

Substituting the numbers in the equation for wood, we find

$$b^3 = \frac{1500 \times 5}{20500 \cdot k} = \frac{1}{2 \cdot 73\, k}$$

Let $k = \frac{5}{7}$, then $b^3 = \frac{1}{1 \cdot 95}$, and $b = 0 \cdot 781$, or 9¼ inches, $a = \frac{5}{7} b = 6 \cdot 8$ inches.

In cases where the weight of the solid is to be taken into consideration, it is necessary, first, to make the calculations, neglecting this weight, which is not yet known, and thus determine the approximate dimensions, from which the weight may be found, and the calculations made again more exactly. In what follows here, no account will be taken of the weight.

Case where the transverse section of the body is a square.—In this case, we have $a = b$, or in equations (A), $k = 1$. The equations (A) will therefore apply to this case, by making $k = 1$.

Example.—What should be the section of a bar of cast iron, of a square cross section, fastened at one end and loaded at the other with a weight of 100 lbs., the point of application of which is 2 feet from the point of support?

Substituting in the formula for cast iron, we get $b^3 = \frac{200}{256000}$ from which $b = 0 \cdot 089$, or about 1 inch.

Case where the transverse section is a circle.—If the body is a solid cylinder with a circular base, we have

$$\left.\begin{array}{lr} \text{For cast iron,} \quad . \quad . \quad . & d^3 = \dfrac{PC}{151756} \\ \text{" Wrought do.,} \quad . \quad . & d^3 = \dfrac{PC}{120700} \\ \text{" Oak or pine,} \quad . \quad . & d^3 = \dfrac{PC}{12070} \end{array}\right\} \text{B.}$$

Example.—What should be the diameter of a rod of wrought iron, exposed to a weight of 1200 lbs., at a distance of 0·2 from the point of support?

The equation becomes $d^3 = \frac{240}{120700}$, from which $d = 0 \cdot 122$, or 146 inches.

The dimensions given by the above formulæ are intended as general values. They are such that the natural elasticity of the body will not be injured. In some cases, a higher value will be given to the constants, but they are intended as maximum limits. In many cases, however, a much lower value must be taken, as for instance, in water-wheel shafts, shafts bearing cams subject to shocks, &c., and in cases where degradation may take place.

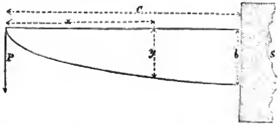
In the multitude of cases which must arise in practice, the constructor will, of course, have to use his judgment, as rules cannot be made to apply to every case; but by careful observation of existing examples, and paying proper attention to proportion, and the laws which govern the resistance of materials, he can hardly very much from the truth. One grand point is, the observation of proportion. That is, to adopt a certain standard for the work, or structure, whatever it may be, and which will depend on the circumstances of the case, and to make all the members proportional, and of a proper form, to resist the strains they may be subjected to.

Solids of equal resistance fixed at one end.—From the equation for the strength of bodies, fixed at one end, and loaded at the other, it is seen that the effect varies, as the distance of the weight from the point of support. Rupture would, therefore, take place at the nearest section to the supported end, the leverage of the weight being greater there than at any other point. It is plain, from this, that if the section at the supported end is sufficient, it must be more than sufficient for the other points. The effect of the weight varies with its arm of lever, but the strength of the section is in proportion to the breadth and the square of the depth, therefore the curve representing the strengths would be parabolic. Its equation would be $y^2 = \frac{b^2}{C}x$, in which x represents the abscissas of the curve, starting from the point of application of the weight

Y represents the corresponding ordinates.

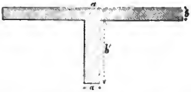
A solid of this form is called a "Solid of Equal Resistance."

Fig. 4.



The annexed figure will give an idea of it. It will be laid out exactly as represented there. The values of P and C are supposed to be first known; from these a and b are formed for the section of rupture, at S; and a being uniform, the depths or values of Y are found from the equation $Y^2 = \frac{b^2}{C}x$, $Y = \sqrt{\frac{x}{C}}$. This equation contains but two unknown quantities, and the substitution of either will determine the other. This is a very convenient form for corbels and the like, intended to support shafting, &c.

Fig. 5.



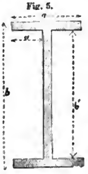
Solids fixed at one end, and strengthened by flanges.—When the cross section of the solid is as in Fig. 5, the formula expressing the relations between the charge and the dimensions is as follows, for cast iron.

When the following proportions are adopted, $a' = b = \frac{1}{5}a$ and $b' = a$, $PC = 102500a^3$.

When we make $a' = b = \frac{1}{5}a$, and $b = \frac{1}{2}a$, the formula becomes $PC = 33825a^3$.

Only the dimensions a of the cross section is introduced in these, because the other dimensions depend on this.

Fig. 5.



When the solid is of the cross section represented in Fig. 6, the following equation expresses the relation, $PC = 256250\frac{ab^2 - 2a'b'^2}{b}$. This form is much used for walking-beams for steam-engines, blowing machines, pumps, &c. The relations between the dimensions are generally as follows:—

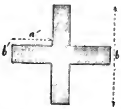
$$a = \frac{1}{4}b,\ a' = \frac{1}{12}b,\ b' = \frac{5}{6}b.$$

The formula becomes for this case $PC = 39360b^3$.

This gives the dimensions for the middle section, the breadth tapering toward the end in the well-known form.

In the case of a solid supported at the ends and loaded in the middle, as in the last instance, the same formulæ apply, but C must be taken to represent the half length of the beam, and P the half weight. Each half of the beam, it is evident, is in the condition of a beam fastened at one end and loaded at the other. If the weight is not applied in the middle, first find, from its position, the effect produced on each of the supports, and consider each portion of the beam as in the condition of a beam fixed at one end and loaded at the other with a weight equal to the effort exerted on its support.

Fig. 7.



Case where the cross section is as in Fig. 7.—In the case where $a = b'$, and $2a' + a = b$, the following formula may be used:

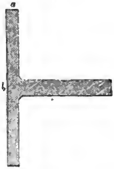
$$P = 256250\frac{ab^3 + ba^3 - a^4}{bC}$$

When $a = \frac{1}{5}b$, the formula reduces to $P = 52890\frac{b^3}{C}$.

This form of beam is not much used to withstand a transverse strain; it is principally seen in the shape of vertical supports, which it is well adapted to, from its great stiffness.

The cross section shown in Fig. 8 is a form much used for water wheels, cog wheels, &c., the side b being in the plane of motion. The following is the formula in the case of water wheels:—

Fig. 8.



$P = 256250\frac{ab^2}{C}$; a is generally made equal to $\frac{1}{5}b$. The width b should be the same through the whole length of the arm, and also the thickness a. The effort exerted at the end of the arm will be known from the number of systems of arms, and the work transmitted to the circumference of the wheel; or it may be calculated directly from the weight of the wheel, and the water in the buckets.

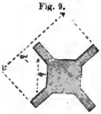
For cog wheels, the formula is the same as for water wheels. In case, however, the wheels are liable to be subjected to shocks, these dimensions must be increased a certain amount—a circumstance in which practice alone can be the guide.

Shafts of water wheels, cog wheels, fly wheels, &c.—The dimensions for these can be found from the following table:—

Disposition of the Weight.	Material.	Formula.
At the middle.	Cast iron, . . .	$b^3 = \frac{PC}{256000}$
	Forged iron, . .	$b^3 = \frac{PC}{205000}$
	Wood, . . .	$b^3 = \frac{PC}{20500}$
At distances s and s' from the points of support.	Cast iron, . . .	$b^3 = \frac{Pss'}{256000C}$
	Forged iron, . .	$b^3 = \frac{Pss'}{205000C}$
	Wood, . . .	$b^3 = \frac{Pss'}{20500C}$
Divided into two equal parts, at equal distances, s, from the points of support.	Cast iron, . . .	$b^3 = \frac{Ps}{256000}$
	Forged iron, . .	$b^3 = \frac{Ps}{205000}$
	Wood, . . .	$b^3 = \frac{Ps}{20500}$
pread over a distance, $2c'$, the middle of which is at distances s and s', from the points of supports.	Cast iron, . . .	$b^3 = \frac{P\left(\frac{ss'}{C} - \frac{c'}{2}\right)}{256000}$
	Forged iron, . .	$b^3 = \frac{P\left(\frac{ss'}{C} - \frac{c'}{2}\right)}{205000}$
	Wood, . . .	$b^3 = \frac{P\left(\frac{ss'}{C} - \frac{c'}{2}\right)}{20500}$

The section of the shaft is supposed to be a square, the side of which $= d$. In case the section is a circle, the same formulæ will apply by multiplying the constant number forming the denominator, by 0·59. In this case d represents the diameter.

Fig. 9.



Shafts strengthened by flanges.—The section shown in Fig. 9 is a very good form for water wheel shafts, &c., being very rigid, and allowing but little flexure. The proportions are generally as follows $b' = 3\,b$, $e = \frac{1}{2}\,b$.

In this case, the formulas to apply (supposing the weight to be disposed as in the last table) are, respectively for cast iron,

$$bs = \quad . \quad . \quad . \quad . \quad \frac{P\,C}{416000}$$

$$bs = \quad . \quad . \quad . \quad . \quad \frac{P\,s\,s'}{416000\,C}$$

$$bs = \quad . \quad . \quad . \quad . \quad \frac{P\,s}{416000\,C}$$

$$bs = \quad . \quad . \quad . \quad . \quad \frac{P\left(\frac{s\,s}{C} - \frac{c'}{2}\right)}{416000\,C}$$

◆

Correspondence.

[For Appletons' Mechanics' Magazine.]

On Warming and Ventilating Houses.

No. 5.

(Continued from page 259.)

The liberation of hydrogen by the action of red-hot heats, and the absorption of the oxygen evolved from the decomposition of water by the heated metallic surface, has undoubtedly a tendency to produce upon the surface a peculiar, though hardly distinguishable oxydization. The presence of combustion, with its tumultuous consequences, is constantly working chemical changes upon the heated metallic surface, so that the actual oxydation is entirely blended, and perhaps lost, with other chemical results. The dangerous appearance of hydrogen in our heated apartments, its causes and consequences, its amount and remedy, all form matters of curious and important inquiry, worthy alike of the attention of the philosopher and the philanthropist.

The elaboration of the enormous latent capacities of combustion for air-warming and other heating purposes, is a problem worthy also of the attention of the savans of every nation. On the result of this, the success of all the really valuable devices for heating apparatus, will in a great measure depend. One result is already obtained in the rule, that the greater the amount of heated, conducting, and radiating surface, the greater will be its effect upon the air surrounding or accessible to it; or, in other words, the larger the amount of air which will be heated, and the sooner the result will be accomplished. The best device, therefore, for affording in some practical, mechanical manner, a large amount of conducting and radiating surface in a small amount of space, and at the least expense, together with the best arrangement of the heated surfaces, so that they shall be suitably and sufficiently exposed or made accessible to cold pure air, is the desideratum required for the first result. The second is the elaboration and distribution of this latent or ordinarily undeveloped heat of the combustion, over and about the large superfices, so as to heat it, and thereby cause it in turn to act upon the air surrounding it, or accessible to its influence.

In accomplishing the second result, water might be suggested as affording a good medium. Steam occupies eighteen hundred times as much space as the water from which it was produced; or, in other words, a cubic inch of water will form a little more than a cubic foot of steam. The heat evolved by the condensation of that quantity of steam, would actually be sufficient to heat six cubic inches of water from the atmospherical temperature to 212°.

Dr. Black, as early as the middle of the last century, observed that every addition of heat applied to a fluid produces an elevation of temperature, until it arrives at the boiling point; but, however violently the fluid may boil, it does not become hotter, nor does the steam that arises from it indicate a greater degree of heat than the water. Thence he inferred that a large proportion of the heat entered into the steam and became latent. Subsequent experiments convinced him of the correctness of this position. He applied heat to a small quantity of water at 50°, and having noticed what length of time was required to make it boil, he continued to apply the heat until all the water was converted into vapor, and found that the vaporization of the water required five times as much heat as was required to make it boil, or 810°; from which he inferred that 810° of heat had been carried off by the steam. Reversing the experiment, he converted a pound of water into steam, and made it pass through the worm of a still, by which he found that 20° of heat were imparted to forty pounds of water in the worm tub, and inferred from the effect produced, that 800° of heat must have been given out by the steam.

It is evident, therefore, that steam is a ready and subtle medium of convection, and as such, in many respects, it is unrivalled. When brought into contact with colder bodies, it imparts to them its rich resources. It is estimated that one gallon of water converted into steam, will heat six gallons at 50° to the boiling point; or eighteen gallons from 50° to 100°, making abundant allowance for waste. The heat imparted to air by steam pipes, is peculiarly fitted for warming houses, diffusing a genial and delightful warmth, combining comfort with cleanliness and safety. Cast iron pipes placed near the floor, constitute suitable and sufficient mediums for the transmission of the heat of steam. Experiments in heating large buildings by this method, demonstrate that one cubic foot of boiler will heat two thousand cubic feet of space to the temperature of 75°, and that one foot of surface of steam pipe is sufficient to warm two hundred cubic feet of space. As applied to cooking purposes, steam is a most valuable, convenient and effective agent. A close boiler of any kind being connected with a range of vessels intended for cooking, steam will rush into them and heat them to the boiling temperature, and maintain them at the same as long as the water in the boiler is kept in a state of ebullition. Food prepared in this way is said to be more nutritious and easier of digestion than the same kind of food prepared in the ordinary way. A small amount of fire, when properly organized and distributed, will keep a large quantity of water at the boiling point, and furnish in the production of steam a sort of latent heat of enormous heating capacities, that may be turned to good account in the warming of buildings.

The location of the stove, or other heating apparatus, is a matter of much consequence, though the writer has never practically experimented on the subject, and founds his opinions simply on what appears to be natural and reasonable. As before remarked, in churches and other buildings, where the construction will admit of it, the stove or furnace (and of course the chimney) should stand near the door. The object contemplated by this arrangement is, that every time the door is opened, cold air rushes in freely, owing to the partial vacuum occasioned by the heat, and by its current drives the warm air back to the opposite end of the room. If the heating apparatus is placed at the end opposite the door, it is self-evident that all its attempts at pervading, and thereby warming the apartment, will be opposed and almost entirely defeated by the cold currents rushing in every time the door is opened. As remarked in a former number, the chimney should stand near the stove, so that long lines of pipe may be avoided, and a direct and unobstructed passage afforded to the smoke and gases. As dwelling-houses are now constructed, it is generally a matter of expediency, not of utility, safety, or economy, that the stove should stand at the side of the wall opposite, and farthest from the door. Perhaps the ingenious builder can easily overcome this difficulty, and so construct his houses that the heating apparatus may stand near the door, together with the chimney, without sacrificing either economy of space or the elegance of the apartment. Where hot-air or hot-water pipes are used, the registers or openings can easily, and without impairing the comfort or convenience of the dwelling, or the economy of its space, even under the present system of construction, be placed near the entrances, and in that position will accomplish their ends more satisfactorily. This is somewhat exemplified by the fact, that in houses where the halls are heated, it has been found that the whole house appears to be substantially heated, the warm air permeating into every apartment, impelled thither by cold currents from the doors. To ascertain the best location for heating apparatus would form another important and interesting subject for the experimentalist, and one well worthy of the attention of the intelligent mason or builder.

High chimneys are sometimes considered favorable to good draught. The principle, of course, can easily be carried too far, so that a chimney might be built so high that it would not draw at all, or ever permit the smoke to get out of it. One of the objects of a high chimney is to carry the points of egress above or beyond the reach of the influences of the currents generated among houses of unequal heights, otherwise these small currents would impede the draught by blowing down, as it is called. The chimney of the small dwelling is carried up above the top of its lofty neighbor. Frequently this is done by sheet-iron pipes, which, in cold or windy situations, are unfavorable in their results, and do not draw well. As before sug-

suggested, earthen pipes are much better, much cheaper, and equally if not more durable.

The proper ventilation of the rooms is a subject next to be considered. It is an important point to all of us, how sufficient pure air shall be admitted, and how the impure air and gases shall escape. Nature, ever wise and beautiful in her dispensations, has already more than half accomplished the desired result, by compelling heated air and gas to rise, thereby relieving us of the many evils that their presence would otherwise occasion. Flues or air chimneys in the walls running from bottom to top, furnish suitable means of exit and entrance. In houses already built without such ventilating flues, apertures might be made directly through the front and rear walls to the open air, by removing a few bricks. Such an aperture need not be, perhaps, over a foot square. On the outside a cast-iron perforated plate may be inserted, and painted, so as to conceal the presence of a hole, yet allow sufficient ingress and egress to the air. On the inside, an ordinary ornamental register, opening and shutting at pleasure, may be arranged and inserted in the usual manner. One of these apertures should be near the bottom and another near the top of the room. They will furnish, when properly organized, sufficient new air for healthy respiration, and aqueous particles therewith to supply the place of those abstracted by the heat. The size of the aperture will vary with the size of the room, the uses to which the room is to be applied, and the number of persons who are expected to occupy or use it. If necessary, in winter or damp weather, the ingress aperture may be made to communicate only with the apartment, by means of a flue running through the floor, and communicating with an air-chamber, forming part of or contiguous to the stove, so that all raw, damp, or cold air may be partially warmed before it is allowed actually to enter the room, thus avoiding all danger of cool currents pervading the apartment.

It is also evident, that no room can be ventilated properly by a single opening. As well might we expect water to run out of a corked bottle with only one aperture, and that in the bottom. There must be another opening to establish the pressure of a current. If there is but one aperture in the room, and that near the ceiling, but little of the heated air or gases will pass out, for the obvious reason, that by such exit a partial vacuum would be formed, which is impossible and repugnant to nature. On the contrary, such a single opening would rather invite a counter-current of air from the outside, which would repel and drive back the deleterious heated gases that we especially desire should pass out. This may be illustrated by pulling down the upper portion of a window, so as to leave a single opening at the top of an ordinary chamber. A person sitting near such window will at once feel currents of cold air falling on his head. Upon opening a door opposite to the window, or a sufficient aperture near the floor, the currents will cease to fall. The practice of opening the upper portions of windows is much in vogue, and is the fruitful source of much mischief. If smoke pervades the apartment, upon opening a single upper window it may be seen at times approaching the opening, and then turning back, as if its exit was repelled. Upon opening a door, however, it will readily and uninterruptedly pass out. This illustration will show the uncertain and impossible ventilation afforded by a single opening. So, too, if but a single ingress aperture is placed near the floor, its inward current will be feeble, owing to the elastic and repelling nature of the air within, and the fulness already acquired. Two opposite openings obviate all difficulty, and establish a proper current, thus aiding in changing and refreshing the entire air of the apartment in a few hours.

For the exit of the heated air and gases, a similar aperture should be opened near the ceiling through the wall, similarly concealed on the outside by a painted perforated iron plate, and a similar adjustable register on the inside. Where there are ventilating flues already in the walls of the building there will be no occasion, of course, to open an aperture directly through, as last above described. To prevent the too rapid escape of useful caloric, the upper aperture might, perhaps, be properly made a little less in size than the lower opening. On the inside, ornamental registers can easily be so adjusted as to partially or wholly open and shut at pleasure. Reasonable ventilation can be obtained in this way, with but a trifling alteration of houses already erected and unprovided with air-flues, without impairing in any way their external appearance, or their stability. Various devices, however, might be suggested to accomplish the same result. The openings should be opposite each other, that is, on different sides of the same apartment, so that the fresh current may traverse across and pervade the whole room. The current, too, would not be so direct and rapid as where the entrance and exit apertures stood directly one above the other.

The apartment that should be properly ventilated above all others is our bedchamber; although this class of rooms is generally wholly neglected in this respect. They are usually very small, and frequently dark and unlighted—the bright sunshine of heaven seldom entering their narrow precincts. In such vaults, one or more persons are compelled to pass entire nights breathing the same air over many times, until carbonic acid and other deleterious gases pervade the entire apartment. Unfortunate bachelors, elevated to attic chambers, sigh for the approach of morning in summer weather, or else sleep per force with open windows, allowing night air with its fluctuating changes to play over their fevered brows. To such rooms a fireplace is a godsend, though operating only as a partial ventilation. A small window over the door assists materially in the purification of the room. An additional ventilator might be suggested, by opening a hole directly through to the chimney flue near the ceiling, with an adjustable register attached. In this way the chimney itself, under ordinary circumstances, will serve as an admirable ventilating flue, without impairing its utility in other respects. Adjustable sliding apertures might be placed in the lower panels of doors for the admission of fresh air.

The flues intended for conveying hot air through the house, or to any of the chambers, should properly be made of some non-conducting and incombustible material, such as earthenware, so as not to attract and absorb any portion of the caloric of the heated air in its passage through them. Wooden flues are perhaps objectionable, on account of their combustible nature. To ascertain the best and cheapest material for this purpose, is a subject of some practical importance, and one also worthy of the attention of the intelligent builder or mason.

When heated pipes or flues are made to pass directly *through* the ceiling to the room above, they are generally made to pass through an earthen or tin circular box, having perforations all around it, so as to allow the heat of the room below to pass directly through. Stoves placed in halls, and drums (as they are called) placed in dormitories, are usually arranged in this way. This practice, though attended with some economy, is, nevertheless, deleterious to health, as this perforated box affords a ready outlet or passage to the heated and noxious gases generated in the room below, to penetrate to the room above. The amount of economy realized is more than compensated by the disastrous results produced. When flues are made to pass through one or more floors, they should pass through air-tight apertures.

Above all, should the thermometer, one of the most useful, cheap, and simple of instruments, form an essential article in every well-regulated household. It should be consulted two or three times daily, and by it the injecting and ejecting registers should be regulated. M.

[To be continued.]

New Publications.

Practical Examinator on Steam and the Steam-Engine, with instructive references thereto, for the use of Engineers, Students, and others. By W. Templeton. From the second London edition. Philadelphia: Henry C. Baird. 1853.

This is a small and convenient volume, designed for the *practical* steam engineer. Being addressed to a class of men and boys who are, in many instances, too heedless, or—to be more charitable—too busily occupied, to demand the more expensive works, we expect to find in such works three qualities of perhaps equal importance, viz., correctness, perspicuity, and attractiveness. The first is possessed by the work in question to an eminent degree; and two or three points which, at first, appeared erroneous, proved by the test of figures to be strictly correct, but deficient in the second quality. The book is too concise and muddy for the class who require it; and lacks the attractiveness, perspicuity, and value accruing from good illustrations. "Bourne's Catechism of the Steam-Engine" is, at present, the standard authority of the engine-room. Being clearly and plainly written, (although equally destitute of plates) its covers are seen among bunches of waste in the tool-box, among oil-cans and sole leather on the blackened shelf, or ranged by the side of "Haswell's Pocket-Book," "Adventures of Dick Turpin," the pair of brass compasses, and the tallow candle, which constitute the apprentice's library. "The Practical Examinator" is not equal to it in value, but is in the same form, being questions and answers on purely practical points, and contains much, especially in tables, which is not in Bourne's. It relates, however, almost exclusively to the English side-lever and slide-valve marine engine. Some two pages are devoted to the effect of locomotives; but, as a whole, we recommend the work to all employed on or studying the marine engine, and no others. To prove the correctness of this criticism would, perhaps, require more labor than was expended in preparing the book itself, being confessedly a mere collection of memoranda for private reference. As a reliable collection of such data, however, it may be eagerly demanded by many, and should meet with a considerable sale. 142 pages 12mo.

New and improved Tables, with the method of their application to finding the mean heights of cross sections (or equivalent level cuttings) and cubical contents of excavations and embankments. By Patrick Lyon, C. E. Philadelphia: H. Carey Baird. 1853.

This is a small volume, which will be readily appreciated. The first table is for ascertaining the mean heights of cross sections, when either two or three cuttings are taken in the field work, and is the only one of the kind ever presented to the profession within our knowledge. The second table for ascertaining the cubic contents is constructed upon the principle of McNeil's Tables, with a proportional difference for tenths of feet—a feature not in the large tables referred to. Both are adapted to every variety of base and slope, and are general in their application. 45 pages 8vo.

Chemistry applied to Dyeing. By James Napier, F. C. S. Philadelphia: H. Carey Baird. 1853.

The following extract from the preface of this well got up volume gives a satisfactory view of the author's design:—

"There are many who, not content with acquiring a knowledge of the mere mechanical routine, desire to look deeper into the principles of the art, and aim at higher honors than those of a mere laborer in it, but who believe that the means of success consist simply in long and steady service, and a good memory for the rules of manipulation. Both of these are valuable qualifications, but neither of them would be depreciated in the slightest degree by being conjoined with a more extended knowledge of the fundamental principles of the art, than usually falls to the share of the practical dyer. There is another evil arising out of this condition of the trade. Individuals who attain the position of good workmen, value their abilities by the contrast which exists between them and the newly-initiated journeyman; but they rarely or never look forward to the wide field which lies unexplored before them. Often, indeed, they boast of their capabilities, of their expertness, and their knowledge; and it is no uncommon thing for them to indulge in petty jealousy, and endeavor to conceal the secret of their mode of working from their neighbors. Under these circumstances, it is no wonder that years are often spent—we should say wasted—in endeavoring to discover what was long before patent to every one who knew the scientific principles of the trade, although ignorant of the practical operations of it. This ignorance of principles often makes both workman and master the dupes of knaves who go about hawking *valuable secrets* at so much a piece."

The book appears admirably adapted to supply the connection between art and science, in this particular and important branch of business. Dyers wish a knowledge of the chemical theory of their manipulations, which neither the lecturer nor the text-book can well supply. The workman or employer may pore over a few pages of high-sounding language, without the least enlightenment. He must be a tolerable chemist to learn the principles—a practical dyer to be understood in explaining them. The distinguished author is in that position, and has accomplished a task which will earn him the thanks of the craft in our country, as well as his own. We subjoin the following extracts from the body of the work:—

"Another circumstance or power, sometimes occurring in dyeing operations, which interferes with or directs chemical affinity amongst the particles of bodies, is, that one body often induces a chemical change in another, while it undergoes no change itself. This kind of affinity, or power, is termed Catalysis. A good instance of this is in fermentation; a little yeast put into beer induces fermentation in all the solution, while the yeast is not altered. If we boil starch with dilute sulphuric acid, the starch is first changed into gum, and then into sugar. Yet, notwithstanding these changes, the sulphuric acid is found unaltered, either in property or quantity. A great many substances possess this property of catalytic influence; and it is not unlikely that fibrous materials, such as silk, woollen, and cotton, possess it towards many of the vegetable coloring matters used in dyeing; indeed, many operations in the dye-house indicate the presence of some such power. The real nature of this power is not well understood; only we know that bodies subject to change by catalysis have their particles held together by a weak affinity, and, therefore, changes are less or more easily effected, according to the power exerted, to keep their elements together. The elements of many organic compounds seem held together by a balance of power among them, so that while another substance put into such a compound may possess a sufficient attraction for some of the elements in the compound, to disturb this balance of power, yet it may not have sufficient power to combine with them, but only cause the whole elements to re-arrange themselves in a new, and probably more stable form. The study of such reactions is of the greatest interest; and as these principles of action, in all probability, play a prominent part in the art of dyeing, it will be again brought under consideration, when describing operations where we think this action takes place. We may here mention, however, that the introduction of such a term as *catalysis* is only considered useful, as bringing under one group a certain class of phenomena; but, indeed, the same may be said of the no less useful term, affinity. When our knowledge of these hidden powers is more extended, all those phenomena may, perhaps, be accounted for, and ranged under the operation of some one universal power or law, of which at present we know only by particular terms."

"The idea of Berthollet, that the green of plants is a distinct substance, existing in the plant, has since been verified. It is obtained by bruising green leaves into a pulp with water, pressing out all the liquid, and boiling the dry pulp in alcohol: when the alcohol is evaporated, there remains a deep green matter, which, by digesting in water, is dissolved, and freed from a little brown coloring matter with which it was mixed. This substance has been named *chlorophyllite*. The formation of the chlorophyllite seems to depend entirely upon the action of the solar rays."

A Manual of Electro Metallurgy, including the application of the art to manufacturing processes. By James Napier, F. C. S. From the second London edition. Henry Carey Baird: Philadelphia. 1853.

We have not the leisure for a proper examination; but the work appears a few years behind the practice of our best American artists. In electroplating, the "solution must be stirred," he remarks—our platers prefer it still. "Gold solution must be hot"—on the contrary, the tendency of hot to crystallize, makes us prefer it cold. Our author makes Smees' battery work 48 hours, while we often work it for a week or more, as now arranged. Notwithstanding slight errors, the work is decidedly the best on the subject with which we are acquainted.

Engineer and Machinist's Drawing-Book. Blackie & Son.

No. 7 has made its appearance. The book is completely adapted to its purpose. The design and execution of both text and plates are admirable.

Monthly Notes.

Our remaining space proving very limited, our "notes" must be necessarily brief. A chemical experiment of the greatest practical importance to the mercantile community has been tried in this city, since our last issue, and occurs to us as the chief event of the month to recognize in this department.

Two large and splendid safes of the most superior workmanship have been burned in competition at the Crystal Palace, until one was destroyed. The safes were laid side by side, supported some 18 inches from the ground, and surrounded by a wall of fire-brick, some 16 inches from their sides, holes being left at the base for draught. Each party chose their position, the "Phœnix" safe lying face down, the "World's" face up. The fuel was coke; both safes being covered and surrounded, and the whole kept at an intense red heat for nearly 24 hours. The interior of the "World's" safe was completely destroyed; at how early a period it is impossible to say. Some books placed in the "Phœnix" were badly blackened at the edges, and their bindings only destroyed, the bodies being completely preserved. We will treat the whole subject more at length on a future occasion.

Apprentices' Department.

Answers to Questions on page 215.

Question 23d. The latitude of the tower being assumed at 49°, and the earth a sphere, it follows that radius : 800 = height of tower :: co-sine 49°, the distance the top of the tower is greater than the distance of the base from the earth's axis. Hence the top of the tower moves *eastward* ·01481318 of a foot per second faster than the base, and the bullet while falling partakes of this motion. The time occupied by the bullet in falling will be 4·8128 seconds ∴ it will fall *eastward* of the centre of the tower, ·740758592448 of an inch.

All resisting media are neglected in this solution,

N. B. Webster, Portsmouth, Va.

Question 27. The man will exert the $\frac{18500}{88000}$ or ·41 part of a horse power; found in this way: If he can raise 150 lbs. 270 feet in three minutes, he can raise the same weight 90 feet in one minute, which is equivalent to 18,500 lbs. raised one foot in that time. A horse power being 88,000 lbs. raised one foot per minute, he exerts $\frac{13500}{88000}$ = ·41 of a horse power.

W. H. McK., N. J.

To Readers and Correspondents.

"H. M. D., Mass. You should have stated what books you now have. We recommend Bourne's quarto Treatise on the Steam Engine. Lardner's Mechanics, Bartlett's Mechanics, D'Aubuisson's Hydraulics, Buchanan's Mill Work, Scott's Engineer and Machinist's Assistant, Engineer and Machinist's Drawing-Book (Blackie), Brande's Encyclopædia, &c. Read our book notices for the past year. Among periodicals, we incline to the London Civil Engineer and Architect's Journal. We, of course, recommend our own Journal as of much practical value; and hope soon to see it closer approach to what such a work should be.

"C. P.," N. J. Will attend to your drawing immediately.

"W. J. J.," Mass. Your propeller will work on a small scale, but not on a large one. It is worthless.

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